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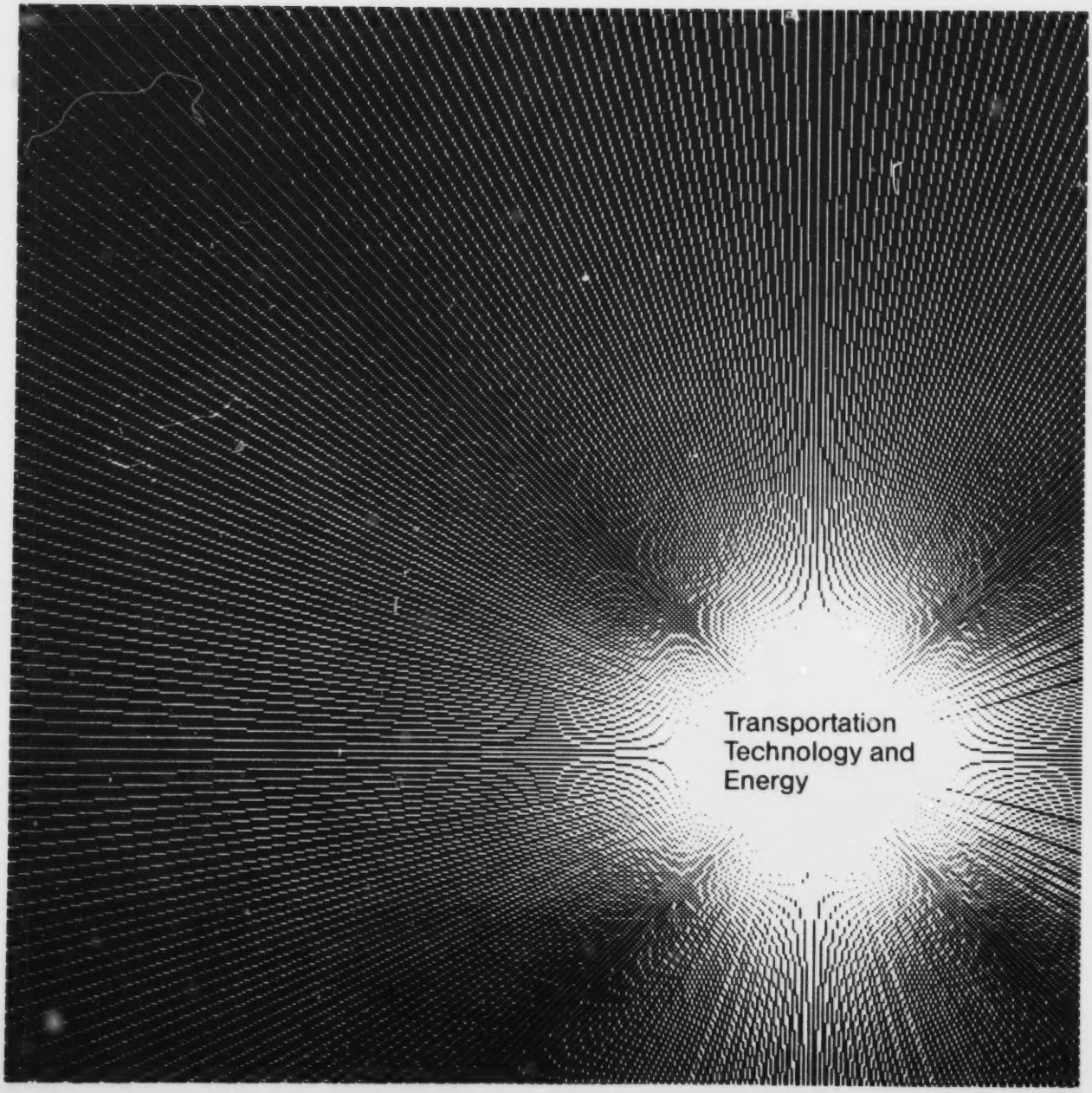
Areas of Opportunity for the Use of Telecommunications to Substitute for, or Complement Transportation



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Abstract

This report combines available information and the expertise of the authors in a study of opportunities to use telecommunications as a substitute for, or complement to, Transportation. General areas of opportunity are identified and a framework is provided for evaluating these opportunities.

Two variations on a recommended evaluation procedure are demonstrated using assessments and criteria weights developed by the authors.

Finally, suggestions are made regarding the use of this document as an aid to decision-making.

Key Words Transportation, telecommunications, substitution, complementarity, opportunities, assessment, energy.

Comments

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TABLE OF CONTENTS

	PAGE
ACKNOWLEDGEMENTS	iv
EXECUTIVE SUMMARY	vi
1/ RESEARCH OBJECTIVES AND SCOPE	1
1.1/ Objectives	1
1.2/ Scope	1
2/ TELECOMMUNICATIONS AS A SUBSTITUTE FOR OR COMPLEMENT TO TRANSPORTATION	3
2.1/ Study Requirements	3
2.2/ Research Framework	4
3/ ANALYSIS OF COMMUNICATION NEEDS AND TRANSPORTATION ACTIVITIES AND OPERATIONS	7
3.1/ Introductory Remarks	7
3.2/ "Substitutable" Communication Needs	7
3.3/ "Complementable" Transportation Activities and Operations	9
4/ TRANSPORTATION-TELECOMMUNICATION INTERRELATIONSHIP — THE INFLUENCE OF MAJOR FACTORS	14
4.1/ Introduction	14
4.2/ Transportation, Land Use and Spatial Factors	15
4.2.1/ Intra-Urban/Intra-Regional Communications	15
4.2.2/ Inter-Urban Communications	17
4.2.3/ North-South and East-West Communications	18
4.3/ Technological, Planning and Institutional Factors	18
4.3.1/ Computer Developments	19
4.3.2/ Communications Technology	20
4.3.3/ The Confluence of Computer and Communication Technology	21
4.3.4/ The Advent of Office Automation	21
4.3.5/ Planning, Marketing and Institutional Factors	22
5/ AREAS OF OPPORTUNITY FOR THE USE OF TELECOMMUNICATIONS TO SUBSTITUTE FOR TRANSPORTATION	25
5.1/ Introduction to Areas of Opportunity and Impacts	25
5.2/ Business/Work-Related Telecommunications	26
5.2.1/ Teleconferencing	26
5.2.2/ Office Automation, Electronic Mail, Electronic Funds Transfer	30
5.2.3/ Remote Work Centre — Satellite Office	31
5.2.4/ Home Office	31
5.2.5/ Experience With Substitutes/Case Studies	32
5.2.6/ Available User Survey Results	33
5.3/ Other Applications	34
5.3.1/ Teleshopping	34
5.3.2/ Telemedicine	34
5.3.3/ Tele-education (Telecourse)	35
5.4/ Impacts of Substituting Telecommunications for Transportation	36

PAGE

6/ AREAS OF OPPORTUNITY FOR THE USE OF TELECOMMUNICATIONS TO COMPLEMENT TRANSPORTATION 41
6.1/ Areas of Opportunity and Impacts — General Description . . . 41
6.2/ Telecommunications Complements 41
6.2.1/ Urban/Regional Road Traffic or Service Improvements. . 41
6.2.2/ Public Transit User Information Services 44
6.2.3/ Transit Vehicle Fleet Control 45
6.2.4/ Ride-Sharing Service 47
6.2.5/ Freight Transportation and Distribution Management . . 47
6.2.6/ Telecommunications in Urban and Transportation Planning 49
6.3/ Impacts of Opportunity Areas 49

7/ TECHNIQUES FOR ASSESSING OPPORTUNITY AREAS 51
7.1/ Assessment Requirements and Criteria 51
7.2/ Assessment Techniques 55
7.3/ Demonstration of Selected Assessment Models 60

8/ RECOMMENDATIONS 63
8.1/ Uses of This Report 63
8.2/ Future Research 63
8.3/ Further Procedures and Resource Persons 65

9/ SUMMARY 68

REFERENCES 74

APPENDIX A/ ANNOTATED BIBLIOGRAPHY 80

LIST OF TABLES

	PAGE
1/ "Substitutable" Communications Needs	10
2/ "Complementable" Transportation Activities and Operations	13
3/ Factors Favouring the Development of Transportation Substitution Opportunities	18
4/ Factors Favouring the Development of Computer-Communication Complements to Transportation	19
5/ User Satisfaction with Communication Media	32
6/ Selected Attributes of Transportation and Telecommunications (Levels of Service Variables)	33
7/ User Benefits Arising from Teleconferencing	34
8/ Preliminary Estimates of Selected Impacts (Comparative Estimates Based on 1980 Base Year)	44
9/ Qualitative Assessment of Selected Impacts (Impacts Assessed in Relative Terms, Range: Very Low to Very High	45
10/ Preliminary Estimates of Selected Impacts (Comparative Estimates Based on 1980 Base Year	61
11/ Qualitative Estimates of Selected Impacts (Impacts Assessed in Relative Terms, Range: Very Low to Very High	63
12/ Criteria and Measures of Effectiveness	68
13/ Criteria Weights	75
14/ The Effectiveness of Substitution Opportunity Areas : Example Assessment No. 1	78
15/ The Effectiveness of Complementarity of Opportunity Areas: Example Assessment No. 1	79
16/ Opportunity Area Rank and Final Score Example Assessment No. 1	80
17/ The Effectiveness of Substitution Opportunity Areas: Example Assessment No. 2	81
18/ The Effectiveness of Substitution Opportunity Areas: Example Assessment No. 2	82
19/ The Opportunity Area Rank and Final Score Example Assessment No. 2	83

LIST OF FIGURES

1/ Study Framework	5
2/ The DOVER System	54
3/ Computer Dispatch System	57

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The views expressed herein are those of the authors alone and are not necessarily those of the MTC or Carleton University.

EXECUTIVE SUMMARY

This report combines available information and the expertise of the authors in an extensive study of opportunities to use telecommunications as a substitute for or complement to transportation. General areas of opportunity are identified and a framework is provided for evaluating these opportunities. The study is summarized briefly below in terms of tasks accomplished; a more detailed summary is provided in Chapter 9:

1/ Twelve areas of opportunity are identified, with a summary of information related to each area.

The opportunities for substitution are:
- teleconferencing,
- remote work centre (satellite office),
- remote work centre (home),
- teleshopping,
- telemedicine, and
- telecourse.

The opportunities for complementarity are:
- urban and regional road, traffic and driver service improvements;
- public transit user information services;
- public transit vehicle/fleet control — location monitoring and dispatching;
- real-time ride-sharing;
- highway freight transportation and distribution management; and
- telecommunications in urban and transportation planning.

2/ Major factors that will influence developments in these areas are discussed, with a focus on:
- telecommunications technology,
- telecommunications planning,
- telecommunications institutions,
- land use, and
- spatial factors.

3/ Thirteen evaluation criteria are identified and defined:
- user benefits,
- efficient use of transportation infrastructure,
- efficient use of telecommunications infrastructure,
- petroleum fuel savings,
- environment,
- commercialization time,
- commercialization and promotion cost to government,
- implementation cost to government,
- transportation industry benefits,
- telecommunications industry benefits,
- stimulation of the economy, and
- usefulness of government involvement.

4/ The following evaluation procedures are described and assessed:
- pros and cons,
- economic efficiency,
- cost-effectiveness,
- goal achievement,

- expected utility, and
- Delphi.

5/ Two variations on the goal achievement method are demonstrated — the demonstration involves making qualitative and quantitative estimates of the likely impacts of developments in each area of opportunity in relation to each evaluation criterion. The effectiveness score for any opportunity is determined by the product of the weight of each criterion and the relative value estimate of its effectiveness in achieving that criterion. The resulting relative evaluation of these opportunities is largely illustrative because it is based on criterion weights suggested by the authors.

6/ Recommendations are offered regarding the use of the material to support the Ministry's decision-making process. In general, it is recommended that technical experts should estimate likely impacts (supported by information and analysis of the type included in this report); the relative importance of different criteria should be assessed by policy experts. Suggestions are also provided about ways of adapting these evaluation procedures to a range of related situations.

7/ Resource persons who could provide additional expertise in this area are listed.

8/ An annotated bibliography of relevant literature is also included.

The analyticial procedures used to develop the lists of opportunities and evaluation criteria are sufficiently explicit to allow for modifications to be made to suit opportunities of interest and evaluation criteria of concern. Decisions regarding the choice of evaluation procedure are supported by a discussion of their advantages and disadvantages.

1/ RESEARCH OBJECTIVES AND SCOPE

1.1/ Objectives

This research project is intended to identify areas of opportunity for the substitution of telecommunications for transportation as well as for complementing transportation with computer-communication systems. Additionally, this study is designed to provide information for assessment of the substitution and complementarity type of opportunity areas.

Specifically, the objectives of this research are:

1/ To identify opportunities to use telecommunication systems and services (including computers) to perform functions that would otherwise require transportation (i.e., substituting telecommunications for transportation), and also to note travel stimulation effects.

2/ To identify opportunities to use computer-communication systems in support of transportation so as to make more effective and efficient use of existing transportation facilities and/or to support the development of new and improved transportation systems and services (i.e., complementing transportation with computer-communication innovations).

3/ To present information for the purpose of assessing the substitution and complementarity type of opportunities (as noted in 1 and 2 above).

4/ To define tools and techniques that could be used for comparative assessment of opportunity areas and demonstrate the application of a selected technique or techniques.

5/ To recommend procedures for adapting these tools and techniques to the decision-making needs of the Ontario Ministry of Transportation and Communications.

1.2/ Scope

This research project, due to the nature of the subject to be investigated, covers a wide area of information. Inevitably, technological, human behavioural, social, spatial, economic and institutional factors have to be covered at least in general terms as these relate to the various initiatives. Also, in addition to the broad general coverage of the subject, in-depth treatment of selected factors is necessary for the description and assessment of opportunity areas. The reader will note that qualifying statements are made throughout this report suggesting that either the inclusion of some specific opportunity areas or the quantification of particular impacts is beyond the scope of this project. Techniques for assessing alternatives are identified in a comprehensive fashion but only two models are demonstrated here.

In the identification of opportunity areas, although the list of initiatives covered here may be considered to be a rather long one, it is appropriate to note that there are also other initiatives which could be covered in future research work. A number of such initiatives are named in this report. Similarly, within each opportunity area (e.g., telecon-

ferencing) there are specific opportunities that could not be assessed here in a detailed fashion as distinct options. Also, this research identified a large number of factors that affect the interrelationship of transportation and computer-communication systems; only those of primary influence could be investigated here. Finally, the scope of this project is limited to the identification of opportunity assessment techniques and the demonstration of selected methods, namely the goal achievement models. Actual real-world application of these models and/or the implementation of the Delphi technique could form the basis of future research.

2/ TELECOMMUNICATIONS AS A SUBSTITUTE FOR OR COMPLEMENT TO TRANSPORTATION

2.1/ Study Requirements

A general interest in the interrelationship of telecommunications and transportation dates back many decades, but since the early 1970s a substantial number of investigators have focussed on various selected facets of the subject. Currently, a large volume of literature is available, although most publications and reports are mainly on the substitution topic.

The two most relevant studies are those reported by Oberman et al of the Mitre Corporation (U.S.A.) [16] and Robinson et al of Abt Associates of Canada [17]. The present study is designed to go beyond these and other previous studies.

The Mitre Study identifies a number of opportunity areas and through the use of a systematic approach and associated assessment technique, it establishes a ranking of the opportunity areas. Moreover, the Mitre Study provides clear definitions of assessment criteria. A weakness of the Mitre Study is the lack of detailed, technical as well as qualitative descriptions of opportunity areas. Also, the subject of assessment techniques was not covered in a comprehensive fashion.

The Abt Study covered selected opportunity areas in a detailed fashion. However, the coverage of the subject is limited to qualitative descriptions and analyses of opportunity areas. There is a lack of substantial analytical and statistical orientation. On the technology side, technical and related planning and institutional factors are not treated to a satisfactory level of detail. Additionally, the coverage of opportunity areas is not comprehensive since a number of interesting transportation complements and substitutes are not discussed (e.g., information requirements for transit terminals, and real-time ride sharing).

There are a number of other deficiencies of the Abt Study. For instance, the linkage between opportunity areas is not clear (e.g., the link between electronic funds transfer and business (work) locations is not explored to a satisfactory level of detail). There is also some overlap between categories of opportunity areas (e.g., electronic mail and electronically automated office). Finally, the Abt Study report does not include assessment guidelines, criteria, methodology, or impact statements which would assist users of the report to establish the relative desirability of opportunity areas.

In general, since the nature of the subject lends itself to much informed speculation, there is a considerable range of future development forecasts or assumptions. Also, in most instances, investigators analysed only a limited number of factors of the complex telecommunications-transportation interrelationship. In instances where a large number of substitution and/or complementarity type of telecommunications-transportation interrelationships are treated, overlapping opportunity areas are noted but their linkages are not defined. Furthermore, the analytical treatment of basic communication needs was either deficient or non-existent.

In order to achieve the objectives of this study as defined in Chapter 1, and to improve upon the deficiencies of other investigations, the following requirements were defined for this study.

1/ The investigation of substituting telecommunications for transportation should view the subject from a broad perspective in terms of using telecommunication means for avoiding travel (i.e., travel decision being uncertain) as well as substituting for travel (i.e., electronic communication replacing planned travel).

2/ The issue of travel stimulation that could potentially result from the availability of low cost and convenient telecommunication systems should be addressed.

3/ The treatment of basic communication needs, transportation activities and operations in search of substitution or complementarity type of opportunity areas should be analytic in nature.

4/ The opportunity areas defined through this research should be exhaustive, with minimal overlaps, and consistent in their level of generality.

5/ While current status of the subject should be described, it is required that a "future" perspective should be adopted in this investigation in terms of technological developments, system design improvements, user attitudes and institutional factors.

6/ Communication contexts and interest groups should be clearly identified.

7/ Due to a number of factors that characterize the various opportunity areas, a systematic methodology should be defined for the assessment of their desirability for research, development and demonstrations.

2.2/ Research Framework

In response to the above requirements, a framework was developed for the implementation of the present research endeavour. The study framework is shown in diagrammatic form as Figure 1. A notable feature of the approach implicit in the framework is that of starting with a broad perspective of communication needs first and then narrowing it down to those tasks that offer the potential to substitute telecommunications for travel(or to simply avoid travel). It was believed at the outset of this research that this approach would lead to a more exhaustive list of opportunity areas and thus offer a safeguard against settling down at the outset to specific telecommunication applications. Also it was intended as a part of this process that the question of travel stimulation be addressed. Likewise, it was intended that opportunity areas for complementing transportation with telecommunication systems should be arrived at by adopting a similar comprehensive approach. That is, the first step to be taken was to identify by type those transportation activities and operations that could be assisted through telecommunications and computers. Out of this analysis, attractive areas for such applications were to evolve for further considerations.

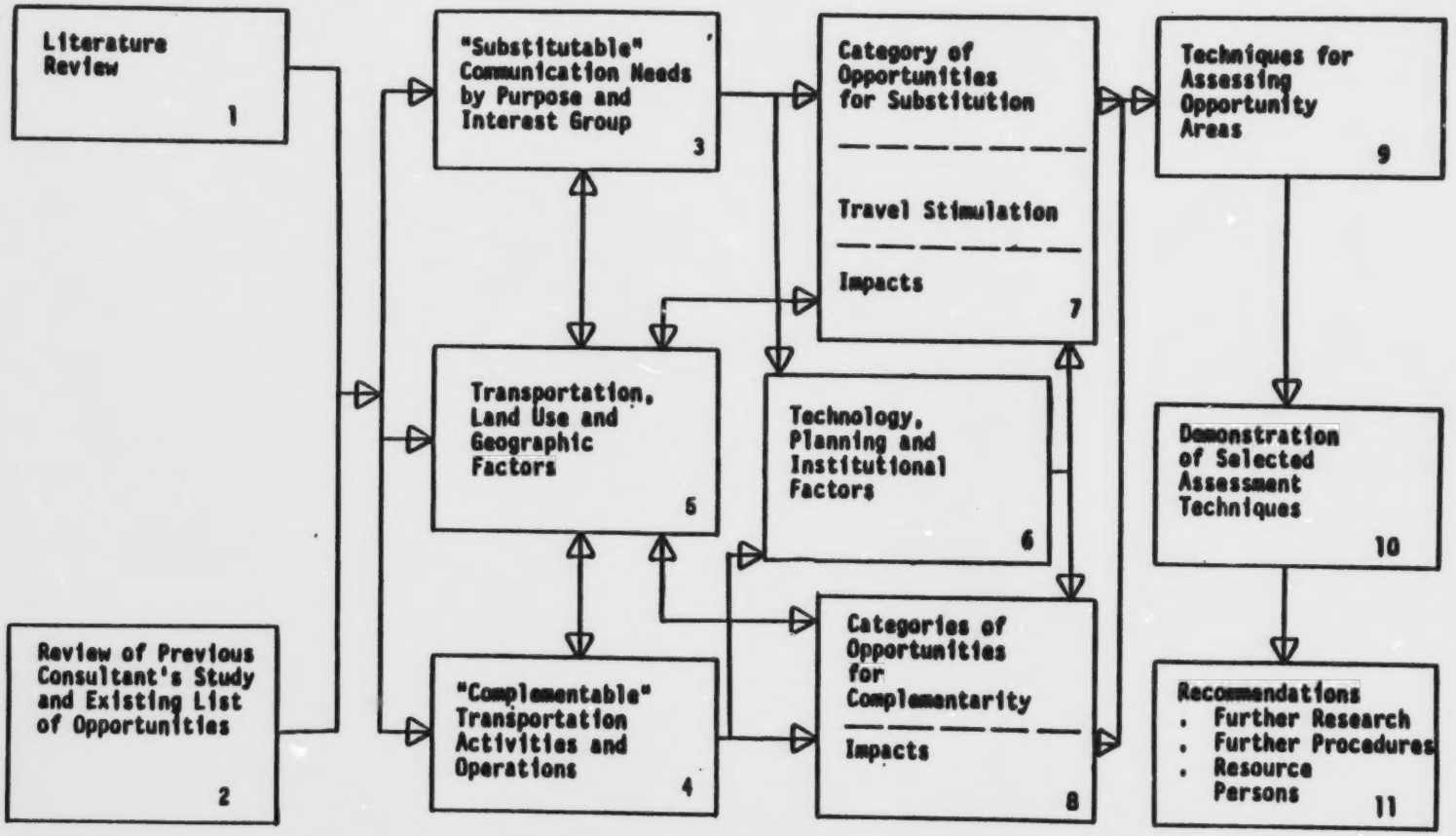

Figure 1/ Study Framework

The specific work plan that was followed in this study consisted of eleven items described below. The sequence of these items is shown in Figure 1.

Item 1
A review of selected Canadian and international literature was carried out, including published journal articles, research reports and working documents. Also, interviews were conducted by telephone or in person with those knowledgeable about the existing or planned applications of telecommunication systems that are intended as travel substitutes or complements to transportation. Annotation of selected literature was carried out as well.

Item 2
A review of a consultant's study (sponsored by MTC) was conducted, including the list of specific opportunities and the associated literature contained in the report. Relevant literature annotations contained in the consultant's report were retained and included in the present report.

Item 3
Research activities included in this item are the definition of communication needs of the various interest groups, stratified by purpose and types of communication, and the delineation of those communication needs that normally involve travel but could potentially be carried out entirely through telecommunication systems.

Item 4
For passenger and freight transportation systems, those existing operations and activities (e.g., scheduling, dispatching, etc.) were identified which could potentially be made more productive through application of communications and computers. Similarly, new operations and activities in the provision of transportation services were identified that could potentially increase productivity and could be made possible by communications and computers.

Item 5
Existing and projected developments in urban patterns, and urban, regional and intercity transportation were defined.

Item 6
Technological developments in computer-communication systems were examined in terms of performance and cost. Such developments were reviewed from the perspectives of:
- their function and network characteristics for serving the needs of transportation or
- serving as substitutes for travel.

Also, planning and institutional factors related to telecommunication technology were analysed from the viewpoint of identifying barriers to successful applications.

Item 7
From the broad set of communication needs defined in Item 3, categories of opportunities for substituting telecommunications (and associated devices) for travel were defined. Potential impacts of these substitution opportunity means were identified. Also noted were the travel

stimulation effects. In the development of the list of substitution opportunity areas, every effort was made to make the list exhaustive, avoid significant overlaps between categories of substitution areas, and maintain consistent levels of generality. In cases of inevitable overlaps (e.g., between teleconferencing and remote work centre), linkages between opportunity areas are described.

Item 8
From the broad set of transport activities and operations that could be assisted through communications and computers, as defined in Item 4, categories of opportunities for such applications were identified and their impacts were studied. Every effort was made to be comprehensive in the identification of opportunity areas and also to satisfy other requirements as stated in Item 7.

Item 9
For the purpose of assessing opportunity areas, assessment requirements, criteria and techniques were required. Three requirements for assessing opportunities were defined to be:
- the definition of criteria,
- quantification of criteria achievement levels, and
- weighting of criteria.

A number of assessment criteria were developed with reference to the objectives of the users, carriers, industry and governments.

Item 10
In this research step, a demonstration of selected assessment techniques was carried out. The intent here was not to create a firm ranking of opportunities as a part of study recommendations. Rather, the demonstration is intended to illustrate the use of the assessment methodology.

Item 11
In the final step of this investigation, a number of recommendations are made on further research as well as procedures for assessing the potential of research areas. Also, a list of resource persons was compiled for further consultations on the subject of this study.

3/ ANALYSIS OF COMMUNICATION NEEDS AND TRANSPORTATION ACTIVITIES AND OPERATIONS

3.1/ Introductory Remarks

An exhaustive identification of opportunities for the substitution of telecommunications for travel must begin with an analysis of the communication needs that underly transportation. A similar approach to the identification of complementarity types of opportunities must begin with an analysis of basic transportation activities and operations. Such approaches are useful for identifying opportunities and in addition, provide a conceptual basis for estimating current and future impacts of these opportunities.

In this research, "substitutable" communication needs are identified on the basis of a classification system which at the outset separates travel-generating communication needs into:

- person-to-object interactions, and
- person-to-person interactions for business/work, personal and social interactions.

Communication needs for business purposes are further classified into information transmission/exchange, routine types of information exchanges, information exchanges about recent events, exploratory exchanges, transactional exchanges, planning, implementation-oriented, crisis decision-making, crisis management, and other communications.

An assessment of substitution potential suggests that conceptually all business communication needs are substitutable, with the exception of those that are transactional (i.e., negotiation with risk) and crisis management when travel time is allowed. Other communication needs that are generally regarded as non-substitutable are those personal communications that normally require direct face-to-face meetings. Chapter 5 reports detailed analyses of selected telecommunication substitutes for transportation.

The approach followed in the delineation of "complementable" transportation activities and operations involves the functional classification of modal components, and for each modal component, the identification of those tasks that are assessed by the research team to offer cost-effective applications of computer-communication systems. The rationale for such potential applications includes factors such as productivity and efficiency of existing activities and operations, and the feasibility of initiating new operations. Through this analysis, a large number of computer-communication complements to transportation are identified. The most promising opportunity areas are analysed in Chapter 6.

3.2/ "Substitutable" Communication Needs

In the pursuit of satisfying human needs, generally classified as biological, material and psychological, a number of activities are undertaken by people which involve human interaction. Communication as a mode of human interaction includes both "face-to-face" communication involving transportation, and telecommunication. Thus, both transportation and telecommunications enable human interaction and contribute directly or indirectly to the satisfaction of human communication needs [18].

Most forms of communications serve many diverse interest groups. These range from the individual and family to businesses, institutions and cultural organizations. Transportation naturally serves the essential purpose of enabling face-to-face communication whenever desired provided that it is available, affordable and convenient. Telecommunications, on the other hand, by making the right information available at the desired location, at the desired time, can certainly improve the quality of the decision-making process both individually and collectively, provided that its use is affordable and convenient, and the quality of the message is acceptable. The needs underlying travel arise from the activities or actions to be performed at the trip destination. From a knowledge of the underlying needs and the activities, the demand for transportation is established. The need for travel, therefore, is the demand potential and is expressed by consumers' travel decisions provided that the potential is satisfied.

In any investigation of "substitutable" communication needs, two interrelated factors are to be understood. These are:
- the nature of communication (and tasks to be performed), and
- individuals' behavioural attitudes and preferences towards the medium, which is partly influenced by the "quality" of the medium.

In this section, on the basis of available knowledge, an attempt is made to define those communication needs regarded as "substitutable".

Travel-generating communication needs could be classed as [18, 19]:

- person-to-object interaction
  - visual contact only; inspection
  - visual and physical; message orientation, use of fixed equipment, use of tools and instruments, acquiring goods, and acquiring information

- person-to-person interactions (business/work, personal business, social)
  - face-to-face
  - written or printed
  - audiovisual

The above classification takes into account the purpose of communication in terms of business or work, personal business and social communication. Also, the parties involved in the interaction are identified. In the case of person-to-object types of communications, some interactions can take place without travel through the use of remote visual inspections, remote monitoring of instruments, remote manipulation of objects or tools, or a combination of the above. Person-to-person interactions could involve both substitutable and non-substitutable communication needs depending largely on the purpose of communication (i.e., business, social, etc.). Table 1 attempts to show, in detail, communication needs, potential for substitution, and telecommunication substitutes.

It should be noted here that the decision to substitute telecommunications for travel involves a complex process rather than a single act. Our knowledge of this process is incomplete since it involves the individual's value structure, the organization to which he/she belongs, organizational directives in respect of communications and travel, the main

Table 1/ "Substitutable" Communication Needs

Communication Need	Substitution Potential	Telecommunication Substitute
Business		
· Information transmission/ exchange		
Messages/mail	substitutable	Electronic messaging/mail
Ordering items (shopping for businesses)	substitutable	Teleshopping
Funds transfer	substitutable	Electronic funds transfer
Transmission of data	substitutable	Data communication
Forms processing	substitutable	Teletext
Transmission of text/word processing	substitutable	Teletext
Joint authorship	substitutable	Teletext
· Information exchange (routine)	substitutable	Teleconferncing
Sales Meetings		
Staff training		
New product or service introductions		
Committee meetings		
Project control and status reporting		
· Information exchange about recent events	substitutable	Teleconferencing
Scientific and technical information exchange		
Seminar		
Problem solving		
Remote consulting		
· Exploratory -- identification, review of considerations basic to establishing a policy or plan of action	substitutable	Teleconferencing
· Transactional -- airing conflicting views, discussion of incompatible factors, resolution by discussion and/or compromise (i.e. negotiations with risk)	non-substitutable	

Table 1/ "Substitutable" Communication Needs

Communication Need	Substitution Potential	Telecommunication Substitute
. Planning -- formulation of a plan, establishing priorities, selection of alternative courses of action	substitutable	Teleconferencing
. Implementation oriented (i.e. administrative activities) -- development, assignment of responsibilities for action (delegation of work), scheduling	substitutable	Teleconferencing
. Crisis decision-making, crisis-management		
Speed necessary -- almost instant decision required	substitutable	Teleconferencing
Travel time allowed	non-substitutable	
. Other		
Social services -- including those for handicapped persons	substitutable	
Education (course)	substitutable	Telecourse
Medical information exchange	substitutable	Teleconferencing
Shopping (households)	partly substitutable	Teleshopping
Voting	substitutable	ICTV
Personal communications (that normally require face-to-face meetings)	non-substitutable	

communication task, activities or tasks associated with the main communication need, the available transportation and telecommunication modes, and external factors [20-24].

A rationale for the delineation of "substitutable" (business/work-related) communication needs is based on the following classification.

1/ Communications where, under normal circumstances, face-to-face meeting is necessary either because of the nature of the task (negotiations, crisis decision-making or decision-taking with risk) or the necessity of a "face-to-face" communication atmosphere for meeting (friendly relations, courtesy, personal contact).

2/ Communications which clearly require a telecommunication service (due to urgency in decision-making) and which involve not more than a limited number of participants (e.g., crisis decision-making, crisis management).

3/ Communications where trade-offs between face-to-face and telecommunications are meaningful, based on the utility structure of the communicants. This type of face-to-face communication is expected to perform such tasks as information transmission/exchange, exploratory, planning, implementation-oriented and performance review.

About 50% of business meetings normally involve the third type of communications.

Non-business types of communication needs, including transmission of social services, communication needs of handicapped persons, and medical information exchange, are substitutable. Personal communications that normally require face-to-face communication are not substitutable. However, there is a trend toward greater substitutability of personal communications. Shopping by households is partly substitutable. Shopping by businesses and institutions is substitutable.

3.3/ "Complementable" Transportation Activities and Operations

Although a number of applications of computers and communications have already been implemented in Canada and elsewhere, the full potential of such innovations has not yet been realized in transportation modes except, perhaps, pipelines [16,17,25,26,27]. Table 2 lists complementable activities and operations in transportation which are believed to be worthwhile in economic terms.

In the case of road traffic, six complementable activities are identified — network control, traffic advisory system, freeway ramp metering and surveillance, speed limit enforcement and advice, and congestion pricing. Among these, network control, ramp metering and surveillance have already been made possible through the application of computer-communications. Speed limit enforcement, variable speed estimation and advice is at the research and development stage. Motorist information systems, in the form of highway advisory radio and variable message signs, have been implemented. Congestion pricing, on the other hand, can be implemented only if a special system is designed and tested. The first such system is expected to go into operation in Hong Kong in 1987. Benefits of road traffic flow improvements include reduced vehicle delay, ability to

Table 2/ "Complementable" Transportation Activities and Operations

Mode, Component	"Complementable" Activity and Operation
Urban and Regional Road Traffic Flow	
• Signals	- central control of large areas of street networks (area-wide traffic signal coordination, automating and optimizing traffic control, adaptive flow systems)
• Motorist Information Aids	- urban traffic advisory system (information on conditions of traffic and weather)
• Freeway Ramp Control and Surveillance	- central control of freeway entrance ramps; surveillance of traffic flow
• Speed Limits	- speed limit enforcement (automated systems)
• Congestion Pricing	- computer-aided automatic congestion pricing
Urban Public Transit	
• User Information	- information about transit schedules and arrival times - vehicle position monitoring - automated information systems (for public transportation terminals; bus number/stall/-time) - information system for the handicapped
Transit Fleet Control	
• Location, Monitoring Dispatching	- automated vehicle monitoring and (location, load, speed), and control-monitoring dynamic state of transportation service supply - vehicle scheduling, dispatching and routing
Urban Transportation	
• Ride-Sharing	- information systems in support of ride-sharing and car pooling (real-time information needs)

Motor Trucks	
• Freight Transportation and Distribution Management	- dynamic inventory of shipments - dynamic inventory of equipment - handling and transmission of data about shipments - scheduling of vehicles and making interline arrangements - dispatching and communication with collection-distribution vehicles - assignment of loads to vehicles when both loads and vehicles are widely dispersed and information has to be updated over short intervals of times - transmission of rates information to customers - automatic billing & funds transfer - cost accounting - multi-station message requirements
Air Transportation	
• En Route Air Traffic Control	- computer-aided decision-making for sector controllers - data link (air/ground) in addition to computer-aided decision-making
• National Flow Control	- central control of aircraft flows to equalize load and system overloading during traffic peaks
• Terminal Air Control	- implementation of computer-aided decision-making and data link (as shown for en route center)
• Flight Service Stations	- centralization and computerization of services provided with a concurrent increase in "remote" local information availability
• Air Cargo Information Systems	- inventory control and waybill processing
Railroads (Freight)	
• Line-Haul	- additional centralized traffic control
• Freight Car Utilization	- dock-to-dock scheduling of rail freight cars
Passenger Railway	
• Ticketing	- improved intermodal scheduling and ticketing capability
Pipeline	- this mode is well served by communication technology

Note: Complementable activities and operations in air and rail modes are sourced from Harkness, R. [25].

manage traffic demand, improved roadway capacity, improved safety, lower vehicle operating costs, energy savings and environmental quality improvements.

Urban public transit of the guided rail type (i.e., conventional rapid transit, light rail transit) is already well served by computer-assisted communications technology, mainly for short headway information (e.g., the system "560" for the Ottawa-Carleton Transportation Commission). These systems attempt to satisfy passengers' needs for information such as routes, location for meeting the bus or transfer, time to meet the bus, recognition of the appropriate bus, and point to alight from the bus. Advantages (benefits) of user information services and associated management information include reduced number of supervisory personnel, savings in clerical schedule monitoring, increased patronage, savings in bus fleet, and fuel conservation.

Transit fleet control requires locating vehicles on a real-time basis, monitoring their performance, scheduling and dispatching. These functions can be assisted by telecommunications and computers at a reasonable cost. Benefits include savings in bus fleet, increased patronage, reduced manpower requirements for scheduling and control operations, and fuel savings.

Another area of transportation which could be assisted by computer-communications technology is that of ride-sharing in urban areas. Information systems could support ride-sharing (car pooling and van pooling) for dynamically matching supply and demand. Benefits include energy savings and improved roadway capacity utilization.

A large number of activities in highway freight transportation and distribution management can be made more productive through automation. As shown in Table 2, these can be classified as user information needs and management and administrative information needs. Discussions with trucking companies in Canada indicate that substantial improvements could be achieved through modernization of information systems in support of freight transportation and distribution management. Air transportation activities could also be assisted through applications of information technology, both in air traffic control and air freight management. Table 2 refers to enroute air traffic control, network flow control and terminal air control. Benefits of improvements in these areas include cost savings and capacity gains. Air cargo information support functions could also be complemented through automation.

Freight railroad operations are an area of considerable applications of information technology. Additional centralized traffic control systems could be implemented for increasing track capacity and safety. In the case of freight car utilization information support, Canadian carriers are leaders in the development of automated freight car management systems which result in productivity gains. Finally, the passenger railway carrier could improve its intermodal scheduling and ticketing capabilities which could translate into improved service and consequent ridership gains.

4/ TRANSPORTATION-TELECOMMUNICATION INTERRELATIONSHIP — THE INFLUENCE OF MAJOR FACTORS

4.1/ Introduction

Prior to embarking on the identification and assessment of travel substitutes or the applications of computer-communication systems which complement transportation, it is necessary to investigate those major factors which have a bearing on the success of travel substitutes or complements. Conceptually, a large number of factors, such as those listed below, can be identified which influence the interrelationship of transportation and telecommunications.

- The Economy
  - inflation
  - availability of investment capital
- Land Use and Spatial Factors
  - urban structure
  - spatial context of communication — intra urban/intra-regional, transborder, international, outlying or remote areas
- Transportation Technology and Services
  - fuel systems
  - developments in design and construction techniques
  - cost and convenience of transportation services
- Telecommunication Technology and Services
  - cost and performance of systems
  - technical developments
  - planning and institutional factors
- Resource Costs and Availability
  - transportation fuel (petroleum energy supply problems)
  - other energy sources
  - materials used in the construction of transportation systems
- The Environment
  - air quality
  - water quality
  - noise pollution
- Business Trends
  - relative size of the service sector
  - obsolescence of office equipment
- Comparative Advantage of Ontario
  - technological expertise
  - natural resources
- Lifestyle/Values/Attitudes
  - status associated with modal choice
  - concerns regarding privacy implications of communication services

- **Regulation and Structure of Transportation and Communications Industries**
  - industry structure
  - Ontario government policy
  - federal/provincial government relations
  - U.S./Canada government relations
  - international trade issues

Although the above factors are relevant to this study, only major factors can be treated here due to the scope and orientation of this research.

Table 3 shows the influence of a number of major factors that favour the development of transportation substitution opportunities. These include land use (urban development patterns), transportation service attributes, telecommunication technology and service attributes, energy supply problems and government policy. Similarly, Table 4 shows the influence of major factors on the development of complementarity types of opportunities. These include general economic conditions affecting investment decisions in information systems, and pressures for the carriers to achieve productivity and efficiency gains in order to remain competitive and financially viable (i.e., the situational variables), transportation service attributes, telecommunication technology and service attributes, and other factors that include energy supply problems and government policy of financial assistance and incentives.

In Section 4.2, trends in transportation, land use and spatial factors are discussed and their influence is described in detail. The spatial contexts of communication can be viewed as intra-urban/intra-regional, extra-regional (including intercity, transborder and international) and outlying or remote areas (e.g., Northern Canada). In addition to analysing intra-urban/intra-regional communications, medium and long distance interactions are discussed in Section 4.2.

There are a number of spatial factors that have differential effects on substitution opportunity areas. These include completely decentralized urban development (for both residences and work sites), satellite and corridor type of urban developments containing employment opportunities in addition to residences, and decentralized developments. Decentralization of work sites to a considerable degree could take place in satellite or corridor types of developments. The effect of high density corridors and residential satellites which contain few employment opportunities in this context will be similar to that of the centralized urban pattern with most businesss located in the central business district.

Section 4.3 reviews and assesses a number of factors which are information technology-related and affect the use of telecommunications either as a substitute for travel or as a complement to transportation systems.

4.2/ Transportation, Land Use and Spatial Factors

4.2.1/ Intra-Urban/Intra-Regional Communications

The need for face-to-face contact, and physical contact with or examination of objects was responsible for the concentration of population in urban areas [20, 21]. Advances in affordable transportation in the form of the automobile and a high quality road network were responsible for

Table 3/ Factors Favouring the Development of Transportation Substitution Opportunities

Transportation Substitutes	Land Use			Transport (Urban/Inter-Urban)		Telecommunication			Other Factors	
	Completely Decentralized (Sprawl)	Satellite+ & Corridor Development	Centralized Development	Increasing Cost	Decreasing Convenience	Decreasing Cost	Improved Performance	Increasing Convenience*	Energy Supply Problems	Government Mandated Teleconference Use Policy
Teleconferencing										
. Intra-regional		X		X	X	X	X	X	X	
. Intercity		X	X	X	X	X	X	X	X	X
Work Centre										
. Satellite Office		X		X	X	X	X	X	X	
. Home Office	X	X	X	X	X	X	X		X	
Teleshopping (Household)	X			X	X	X	X	X	X	
Telemedicine						X	X	X		
Telecourse	X			X	X	X	X	X	X	

+ incorporates decentralization of work sites as well as residential areas.

* readily available; for business use, extensive network required.

Table 4/ Factors Favouring the Development of Computer-Communication Complements to Transportation

Computer-Communication Complements	General Economic Conditions		Transportation		Telecommunications			Other Factors	
	Capital for Investment	Pressure to Improve Carrier Productivity	Increasing Cost	Decreasing Convenience	Decreasing Cost	Improved Performance	Increasing Convenience*	Energy Supply Problems	Goverment Policy (Incentives)
Road traffic flow improvement	x		x	x	x	x	x	x	x
Public transit information	x	x	x	x	x	x	x	x	x
Public transit fleet control	x	x	x	x	x	x	x	x	x
Real-time ride sharing	x		x	x	x	x	x	x	x
Road freight transportation & distribution management	x	x	x		x	x	x	x	x
Telecommunications in urban and transportation planning	x		x	x	x	x	x	x	x

* readily available, extensive network.

location of households, businesses and institutional services in wide geographic settings within urbanized regions. Recently, the trend in urban growth patterns has shifted towards planned corridors and satellite communities with good transportation links to the central city.

In addition to the development of residential areas in satellite communities, the recent trend has been to locate work sites and other non-residential activities in these communities. This, however, does not mean that the traditional growth pattern of the central business district of major urban areas has been reversed in terms of business and related activities. There has been more of a balance in the locations of work sites between central business district and the business areas of the satellite or corridor cities.

Currently, the urban structure (at least in large Canadian urban areas) is shifting gradually towards higher density developments. Due to high transportation energy costs, central city residential areas are becoming attractive in spite of increased availability of reasonably efficient automobiles and low cost telecommunication means. The high cost of capital and the relative scarcity of urban lots for single family dwellings are resulting in greater demand for high density residences and clustering of residential areas. The intra-urban transportation implications of the higher density type of urban structure include an improvement in urban transit, and the difficulty of increasing roadway capacity for automobile transportation.

There are a number of issues related to the development of roadway and public transit capacity for peak period use. The issue of cost is most relevant to the present research. It is not cost-effective to keep on expanding peak period capacity since there is, in general, a significant drop in transit and road use during off-peak periods.

Telecommunication substitutes for the work trip are logically a means to create a balance between peak and off-peak demand for transit services and road use for automobile travel. Most variations of the current urban pattern in Canadian cities are suitable for any consideration of telework (from a satellite office or from home). It should be noted here as well that complete decentralization (if allowed by planning boards and facilitated by telecommunications) could have the effect of diverting travel from more energy efficient transit modes (bus, rail) to the less efficient automobile.

An examination of actual location decisions and communication patterns that have evolved suggests that telecommunications have not been a strong force or even a significant causal factor in bringing about decentralized land use patterns in the same way that transportation has shaped land development. Even without the influence of communication technology, the trend is towards controlled decentralization and a higher density urban growth pattern. Any widespread application of computer-communication services is expected to serve the needs of decentralized organizations and institutions [19]. These roles are expected to continue in the future. Thus present knowledge suggests that a completely decentralized urban development pattern may not be shaped by telecommunications in spite of the future technical potential of telecommunications to enable workers to telework from home.

The implication of the decentralization trend coupled with telecommunications could be the elimination of a number of business trips and shorter trip lengths. The consequences of such a phenomenon include energy savings reduced and load on the line-haul facilities serving areas of intense activity.

In large urban areas, the substitution of telecommunications for work trips for certain (largely white collar) tasks may appear attractive to a number of interest groups, including the public agencies charged with responsibility for providing transport services or planning efficient energy use. The telecommunication services could link decentralized work centres with main central business district offices. Satellite communities and regional commercial and business centres could telecommunicate with both central city offices and other satellite offices [23].

4.2.2/ Inter-Urban Communications

In the inter-urban case, from a communications viewpoint, intercity corridors with high population and traffic volumes are also the locations of high telecommunications and data traffic. Historically, transportation ridership and telecommunications traffic have experienced similar trends, with growth in telecommunications surpassing travel growth. Costs of transportation and telecommunications, on the other hand, do not show similar trends since transportation costs have generally been rising faster than communications costs which in many cases have been declining.

From the viewpoint of diverting travel away from transportation modes, high density corridors are attractive due to large volumes of travellers. For this reason, Bell Canada's Travel-Telecommunications Survey of 1973 was carried out in the Quebec-Windsor Corridor [24]. A number of travel modes and Bell Canada's teleconference facilities link major corridor cities. Medium and long-haul travel contexts could also be viewed as locations with substitution potential. Available information and studies suggest that social interaction is becoming relatively more distance-independent as compared to the past. Observations have been reported that during the last decade, communicators have tended to telephone farther away since there has been a substantial increase in the average toll message transmission distance.

Recent and planned developments in intercity public travel modes, on balance, are expected to improve the convenience of travel*. The cost of public transportation is, however, expected to rise due to labour, energy and other cost increases. Potential future fuel cost increases for automobile travel are expected to be largely offset by fuel efficiency improvements of vehicle fleets.

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*Developments in public modes of travel include projected infrastructure and equipment upgrading for rail in selected corridor routes, a favourable decision by the federal government for STOL (air) system, planning study for a third terminal at Malton, and equipment innovations in intercity bus transportation.

4.2.3/ North-South and East-West Communications

North-south travel across the border is reasonably well served by air transportation links, and new services are being introduced (e.g., Ottawa-New York air service). The Canada-U.S. border is the world's busiest border in terms of air travel. Thus, the north-south travel context is an appropriate location for a study of travel versus telecommunication trade-offs.

Northern Canada's communication services could be considerably enhanced through telecommunications. In this case, although travel could be substituted with telecommunications for some communication needs, improved communications could be viewed as an overriding concern.

Transportation needs in the east-west direction are reasonably well served. Although travel is expensive and time-consuming due to the long distances involved, there are inconveniences of electronic communications as well due to differences in time zones. The number of compatible hours for electronic communication between eastern and western cities can be rather small. This difficulty can be overcome to a certain extent by computer-conferencing, described later in this report.

4.3/ Technological, Planning and Institutional Factors Related to Information Technology

In recent years, the "information industry" has achieved considerable prominence as a result of engineering and scientific advances. Five basic operations can be carried out on data — acquisition, storage, processing, transmission, and dissemination. Storage and processing of data are primarily in the domain of digital computing, while acquisition, transmission and dissemination are mainly communication tasks. Although this distinction is useful, information handling systems increasingly combine elements of both computer and communications technology (Sections 4.3.1 to 4.3.3). New services resulting from the advent of office automation are presented in Section 4.3.4. Finally, a number of factors that relate to the implementation of information technology are discussed in Section 4.3.5.

4.3.1/ Computer Developments

Developments in the area of information technology have continued to produce new systems that are smaller, more reliable, more energy efficient, more powerful and less expensive; it appears that this trend will continue for some time. The implications of these developments for substitution and complementarity are discussed in terms of the resulting functional improvements in computer systems. Factors considered include storage capacity, processing speed and mobility as well as trade-offs between these functions. Relevant cost factors are also discussed.

- **Storage Capacity**
  The amount of information that can be stored in a single chip and consequently in a single system has increased significantly. One major implication of this development is that very large amounts of transportation information can now be handled as a single, integrated data set. Storage costs have decreased at about 45% per year for most of the decade [28].

- **Processing Speed**
  The time required to process information (including access time) has decreased significantly. This development has combined with improved reliability to make it more feasible to use computers to support "real-time" decision-making and control systems. In the last decade, processing costs have been decreasing at about 25% per year [28].

- **Mobility**
  Increased reliabilty and energy efficiency have combined with reduced size and costs to greatly improve the mobility of computing devices. The most obvious implication is the greater feasibility of "on-board" systems, but it also means that computing power can be located in small, stationary devices such as telephones.

- **Trade-Offs**
  As the amount of stored information increases, the processing time increases, but this increase can be offset by using systems with higher performance [29]. Although these high performance systems are more expensive, system costs are projected to decline [28]. One important implication of this development is the increased feasibility of fast-responding systems that can handle relatively large amounts of transportation information.

  Recent developments have also provided a wider range of speed/cost trade-offs [29]. This means that it will be more feasible to find optimal systems when there are concerns related to amount of data stored, processing speed and cost. On the other hand, finding the optimal system will require careful analysis of the available options.

- **Costs**
  Although references to costs in the above discussion have been quite positive, it should be pointed out that personnel costs have not followed the same trends as the costs for equipment and operations. The increasing complexity of systems has forced a reliance on highly trained computer specialists. If the value of, and the demand for, their services continues to increase, the rising human costs of computer systems may begin to offset the declining equipment and

operational costs. Although more powerful programming languages will improve the efficiency of computer specialists, it would appear that programming and systems design will continue to be very labour-intensive activities into the foreseeable future.

4.3.2/ Communications Technology

Developments in communications technology have produced new ways to acquire, transmit and disseminate information. There have also been significant improvements in existing systems. The implications of these developments for substitution and complementarity are discussed below in terms of resulting functional improvements in communications systems. Factors considered include communication capacity, communication speed, and mobility of sender and receiver as well as trade-offs between these functions. Relevant cost factors are also discussed.

- Communication Capacity
  The capacity of modern communication systems has been increased by innovations and improvements in acquisition, transmission, and dissemination of information. Improvements have occurred in terms of the amount of information that can be communicated and the number of modalities that can be handled, e.g., voice, text, data and image. This means that one major reason for direct contact can increasingly be eliminated — the need for full information. Another major implication is that there is an increased potential for both remote monitoring and remote control of transportation systems.

- Communication Speed
  Modern communications systems have also increased the speed with which they can handle a wide range of information modes. These developments can often eliminate another major reason for direct contact — the need for rapid information exchange between sender and receiver. Another major implication is that remote monitoring and control of transportation systems can occur at rapid rates.

- Mobility of Sender and Receiver
  Developments in the areas of mobile radio, satellite communications and digital switching have reduced the restrictions on the location of both the sender and receiver of information. These improvements are relevant whether people or physical objects are involved in the interactions. This development further reinforces the potential for interactions, monitoring, and control without direct contact.

- Trade-Offs
  The time required to transmit a message increases with the length of the message, but this increase can be offset by using higher capacity communications systems. Although these high capacity systems are more expensive, transmission costs have been declining at a rate of about 12% per year [28]. One implication of this development is the increased feasibility of quickly transmitting large amounts of information. Recent developments have also provided a wider range of speed/cost trade-offs. As in the case of computer systems, this wider choice allows for better optimization, but careful analysis is required.

- **Costs**
  The same caveat regarding costs of computer services applies to communications services. Rising personnel costs could begin to offset declining equipment and operational costs, especially when systems are complex or when information data bases require frequent, non-automated updating.

4.3.3/ The Confluence of Computer and Communication Technology

It is clear from the previous two sections that developments in computer and communications technology tend to reinforce each other. This mutual reinforcement is strengthened by a recent tendency for a confluence of these two technologies. It is increasingly common to see new and improved systems that combine communications and computer technology. Significant examples include the use of digital technology in the transmission and switching of voice communications and the use of communications technology in distributed data processing networks.

4.3.4/ The Advent of Office Automation

The effects of the declining costs of storage, processing, and communications referred to earlier are now being felt. Perhaps the most dramatic impact will be in the area of office automation. Substantial computing power is now available throughout the business world. An office can install a microprocessor handling word processing, accounting, and other procedures at a cost of about $5000. The resulting possibility is the emergence of the "automated office" in which the computer greatly increases the efficiency and mobility of both professional and clerical workers. Computer-aided filing, information retrieval, management control systems, editing, and spelling correction are simple examples. In this section we shall examine some of the new services which are likely to be associated with the automated office.

4.3.4.1/ Local Area Networks

Most microcomputers purchased for office use are viewed as stand-alone work stations. Inevitably, however, the need will arise for a degree of interconnection of these work stations within a single organization. Boyd has estimated that up to 60% of all business communications traffic takes place within a single building or local complex [28]. Paralleling the development of large-scale computer communications networks is the more recent development of local area networks, whose individual processors are typically microcomputers or minicomputers. While no precise definition exists of the term, a local area network usually implies

> "...a digital communications facility carrying data at high speed among a large number of information processors directly interconnected within a building or adjacent buildings." [30]

4.3.4.2/ Teleconferencing

Teleconferencing allows a group of users to interact through a communications medium in real time. The earliest example of this type is probably the telephone conference call. During the 1970s this approach was extended to include both video teleconferencing and keyboard teleconferencing. The former attempts to approximate face-to-face interaction through the medium of wide-band communications channels, while the latter, much more efficient in terms of bandwidth, is confined largely to written material.

4.3.4.3/ Electronic Mail

Electronic mail in an office setting can be regarded as a special form of computer teleconferencing in which real-time interaction is unnecessary. In a more general sense, however, the concept may be applied to the delivery of messages for the general public as a direct substitute for letter mail. Canada Post has taken considerable interest in this development and is now in the process of defining precisely the meaning of the term "letter". It is technically feasible to implement a universial electronic mail system in the immediate future.

4.3.4.4/ Videotex

The use of television in providing instant access to substantial remote databases, including pictorial material, has received considerable attention during the past five years. These services have come to be known generically as teletex (allowing little or no viewer interaction) and videotex (allowing user manipulation of the database). The perceived commercial opportunities for videotex in particular have given rise to several major technical developments.

4.3.4.5/ Human Factor Barriers to Office Automation

One of the barriers impeding the development of office automation is the nature of the interface between the human and the computer. Many people are averse to using a terminal and feel that esoteric programming knowledge is necessary to carry out any interaction. By and large, office workers communicating with computers will not be programmers themselves. It is therefore necessary that great attention be paid to the man/machine interface. This consideration has led to the development of a wide variety of high level software packages. One type of particular interest is the so-called "program generator". This type of package allows the user to utilize the power of the computer without having to learn the "nuts and bolts" of programming.

4.3.4.1/ Voice Recognition Systems

Probably the most natural form of interaction for humans is speech. Recent developments in voice recognition have led to systems which will recognize up to about 200 words from a single human speaker, with a reliability of more than 95%. This level of recognition, while still quite primitive, is adequate for simple interaction in the office with the use of commands such as "get the personnel file". Efforts are now underway in Japan to develop a computer dictation system with voice input and typed output. It is expected that a Japanese system of this nature will be available by the late 1980s, with an equivalent English system shortly thereafter. The Japanese system is likely to predate the English one by virtue of the more phonetic nature of the Japanese language [31].

4.3.5/ Planning, Marketing and Institutional Factors

The development of computer communications and new services which have resulted were described above. The principal barriers to the widespread implementation of such services were not necessarily technological in nature. The engineering developments necessary for their effective use are foreseeable without the need for major "breakthroughs". However, there do exist planning, marketing and institutional factors which must be addressed if modern telecommunications is to be fully effective.

- **Planning**

  Telecommunications applications in support of human communications require a long-term commitment both at the level of individual organizations and that of various public agencies. Co-ordination is necessary between those bodies charged with the responsibility of planning for transportation, energy conservation, and effective communications in support of productivity improvements. It has been suggested in the literature that the principles of long-term planning are not being applied to the development of services such as teleconferencing and office automation. Without such planning effort, these services may turn out to be extraneous to the functions of the organization, or they might be implemented in a haphazard fashion, lacking adequate standardization and control. For example, in the context of office automation, current developments are largely piecemeal. Much work needs to be done to understand and to define the scope and function of the office process, the nature of its products and services, the flow of information in it, and the man/machine interface.

- **Marketing**

  Two forces, namely market pull and technology push, are at present influencing the development of emerging telecommunications services and media. For some new media, such as computer teleconferencing, electronic mail, and data communications, there is a developing market pull based on needs for productivity improvements in the business and public sectors. On the other hand, for teletex/viewdata and interactive CATV, the main force may be technology push. Sponsoring suppliers would like to avail themselves of the opportunities for sale of equipment and services, but the demand for these is uncertain [32].

  A well known example of technology push is the picturephone. Versions of this have been developed by various telephone companies over the past ten years; however, there has been relatively little market acceptance of this service. The reason for this market resistance appears to be that customers consider that the additional pictorial information in the form of a "talking head" is of little value (and may even be a detriment) when used for normal casual telephone messages. On the other hand, video teleconferencing (the same technology used for formal prearranged multi-party conferences) is making some headway in the market.

- **Institutional Factors**

  Regulations and policies can act as barriers to the implementation of emerging telecommunications services. Opportunities for substitution and complementarity will be stimulated by innovative policies such as those that allow sharing of facilities and enhance the confluence of telecommunication and computer technologies. Such developments will be influenced by a variety of institutional factors. These include:
  - regulations dealing with joint use of services (e.g., satellites) nationally or internationally,
  - regulations related to competition between and within the industrial sectors involved,
  - regulations related to interconnection of telecommunication and computer systems,
  - federal-provincial relations with regard to regulation of the relevant sectors and systems,
  - procurement policies in the public and private sectors, and
  - the development of relevant standards.

The most significant recent regulatory policy developments affecting the use of telecommunications were those of allowing private use of satellite dishes and Canada/U.S. agreement to share satellites. These developments are expected to stimulate teleconferencing. There are other policy changes as well which, if implemented, could increase the use of telecommunications even further. For instance, policies which facilitate the confluence of computer and communication technologies are sometime lacking [33]. That is, policies in either the public or private sectors which maintain organizational distinctions between telecommunications and data processing, or those which restrict the procurement of systems required for integrated systems, can act as barriers. One such barrier is the lack of rationalization of shared jurisdiction between federal and provincial governments [34].

Another key institutional factor is the degree of competition which is allowed between and within the industrial sectors, and especially amongst carriers. The European model, with its government controlled PTT, yields high internal standardization within a very restrictive environment. The American model allows for extensive competition in new services such as data networks. The benefits of rapid innovation are, to some extent, reduced by the resulting chaos in the standards field. In the data communication sector, Canadian policy has steered between these two extremes by allowing the existence of two major domestic data communications carriers.

There is no doubt that standards will be developed over the years which allow for a greater degree of interconnection and resource sharing. It is essential, though, that the Canadian government and the computer/-telecommunications industry maintain a lively interest in standards developments. Some success has been achieved in this area, notably with the development of the international X.25 data networks standards, which was influenced significantly by the TransCanada Telephone Systems' Datapac design. More recently, the Department of Communications has been active in attempts to develop an international teletex protocol. Canadian success in the achievement of a Telidon-compatible standard would open substantial export markets.

5/ AREAS OF OPPORTUNITY FOR THE USE OF TELECOMMUNICATIONS TO SUBSTITUTE FOR TRANSPORTATION

5.1/ Introduction to Areas of Opportunity and Impacts

As discussed in Chapters 3 and 4, telecommunications have the technical capability to efficiently transfer information which could potentially reduce the necessity of physical travel for information exchange type of tasks required mainly in support of business communication needs. A number of other communication needs could potentially be met as well. These include shopping (for household needs), medical information exchange, and education. In this research study, application contexts are discussed mainly from the perspectives of existing experiences and future outlook as to the extent of travel substitution that is likely to occur. Also, impacts resulting from travel substitution are identified. In this section, areas of opportunity are categorized as:

- Teleconferencing
- Remote work centre — satellite office,
- Remote work centre — home,
- Teleshopping,
- Telemedicine, and
- Telecourse.

Experience with office automation and future outlook in this area are discussed as a part of application contexts (i.e., Remote Work Centres) and also as a separate heading due to the importance of the subject. However, office automation, due to its obvious overlap with other substitution opportunity areas, is not treated as a travel substitute category by itself.

A large number of impacts are likely to occur as a result of substituting telecommunications for travel. Although there are some exceptions, the direction of the impacts is generally uniform for all opportunity areas. However, the extent of the impacts differs from one area to another.

Impacts that are quantified in this research include reduction of peak traffic load on transportation infrastructure and petroleum savings. Also, estimates of commercialization time (years) and diffusion time horizon are attempted in this chapter.

Impacts that are assessed to be positive but expressed only in qualitative terms include user benefits, telecommunication industry benefits, improved use of telecommunication infrastructure, environmental quality, and net impact on economy. As expected, costs of implementing telecommunication initiatives are shown to vary considerably among opportunity areas.

The transportation industry in general is expected to experience loss of traffic. The extent of traffic losses would differ from one travel substitution area to another. However, in the case of teleshopping, on the one hand loss of public transit trips is expected and, on the other hand, there is the expectation of increased goods delivery traffic. Finally, an attempt is made to define the role of governments in respect of substitution opportunity areas.

5.2/ Business/Work-Related Telecommunications

5.2.1/ Teleconferencing

As previously noted, there are three basic telecommunication substitutes for meetings in person. These are: audio (including facsimile), video (including audio and graphics), and computer conference.

Video teleconferencing is technically feasible but it is complex, expensive, and is far from representing real person-to-person meetings. For group-to-group meetings, usually only two groups at a time are involved. Recently, multi-location video conferencing has been implemented successfully. Public systems are expected to expand which will overcome the availability and interconnection (among cities) problems.

In the future, the following factors are expected to reduce the cost of video teleconferencing and improve performance: video compression techniques (improving communication channel), cutting out extraneous information from video output, fibre optics, efficient use of satellites (making cost less sensitive to distance), large screens, improved system design from user perspective, and improved capability to transmit documents (through the use of business satellites).

Audio teleconferencing, which is the most accessible type of service, includes the simple telephone "conference call" but may also provide extra capacity for teletyping, telewriting or facsimile. Currently, audio is the least expensive form of teleconferencing, although cost increases with more participants. Also, many locations can be linked at present (e.g., Bell in the U.S. connects 58 locations in North America). Major problems include acoustical problems (such as feedback, reliability and voice quality), conference discipline (i.e., determining the order of speaking), protocol problems (in the absence of visual cues), user's lack of confidence in technology for group conferencing, and problems of voice-switched systems. There are various solutions to these problems including design, technology and protocol changes.

Computer teleconferencing is print-based communications, usually involving 3 to 25 persons. Since participants need not be present simultaneously, time and space barriers are overcome. Cost is low as well and, by the mid 1980s, computer teleconferencing might even be less expensive than audio teleconferencing. Computer conferencing can be enhanced through the use of other resources such as text editors, data bases, journal systems, and data analysis packages or models. Impediments to widespread use include slow service, lack of image and voice, and the necessity to use the keyboard. In the future, improvements are expected such as voice communication with machines.

Recent interest in teleconferencing has come from all sectors of society but businesses and governments have been the main actors. Users can be classified as:

- business,
- governments (federal, provincial),
- universities,
- service industry (banks, health, etc.), and
- residents.

It is believed that businesses could be interested in promoting teleconferencing for the following reasons:

- cost savings arising from substituted or avoided travel,
- time savings,
- flexible management in terms of arranging meetings, avoiding the need for assembling all interested parties in one place at one time, and
- bridging the communication gap when face-to-face meetings are impractical due to dispersed markets or territories.

Governments have additional reasons, such as energy conservation, for an interest in teleconferencing.

Numerous researchers point out that about 50% of normal out-of-office face-to-face meetings (for information exchange) could be replaced by telecommunications. However, in the opinion of this research team, a probable substitution level of 20 to 25% of business travel would be the upper limit. Contents of other meetings, in conceptual terms, would permit some substitution. However, the likelihood of such substitution under normal circumstances would be very small. For this reason, most researchers agree that about 50% of business meetings cannot be replaced by telecommunications.

Media requirements for substituted travel can largely be satisfied by audio (plus visual support). See Table 5 for a summary of user satisfaction with the different media. Although video conferencing offers a richer medium, it may not be necessary for a substantial percentage (e.g., 40%) of communication needs out of the 50% of tasks categorized as information exchange [9].

According to Bell Canada's Director of Long-Range Planning, a successful telecommunications system takes into consideration the concept of "shared communication space" and maximizes interactive discussion. In this regard, a face-to-face meeting is flexible and is the ultimate in shared communication space. It is to be noted that developments in communication technology are increasingly interactive and are becoming richer in shared communication space (e.g., a multiport share writing device used in support of audio and video telecommunication systems).

Travel versus teleconferencing trade-offs have been studied by many researchers. As a part of such research, attributes of transportation and telecommunications are the focal point of substitution decision-making (see Table 6). To go beyond the level of service variables, the benefits accruing to users as a result of teleconferencing may be listed as shown in Table 7.

Among the long list of factors presented in Table 6, recent findings with respect to cost and time are highlighted here. The cost advantage of teleconferencing over travel is expected to increase substantially in the future. Travel and associated accomodation costs are expected to escalate in the future. At present, however, the cost of a video conference between two points in Ontario is nearly the same as the cost of one round-trip journey between those points [9]. Other factors that affect costs include the need to lease facilities and the utilization level of such facilities (i.e., the number of meetings per year). As for the importance of time, access time to teleconferencing studios can be used as an example. According to an OECD survey, the time that the user has to spend to reach a studio can be a considerable disincentive to use.

Table 5/ User Satisfaction with Communication Media

Type of Communication	2 Way Audio	2 Way Audio + Fax., Etc.	2 Way Audio + 1 Way Video	2 Way Audio + 2 Way Video	2 Way Audio + N(2 way Video)	Face-to-Face
Intra-Organization						
(Mostly Acquaintances)						
Operating Discussions	H	H	H	VH	VH	Best
Executive Discussions	L	AV	AV	H	H	Best
Inter-Organization						
(Mostly Strangers)						
Operating Discussions	L	AV	H	H	H	Best
Executive Discussions	VL	L	L	AV	AV	Best

VL = Very Low
L = Low
AV = Average
H = High
VH = Very High

(Compiled from results achieved in field tests).

Table 6/ Selected Attributes of Transportation and Telecommunications

(Levels of Service Variables)

	Transportation	Telecommunications
Cost to User	Cost of service (price of service, access and egress costs)	Cost of service (price of service, access and egress to terminal)
Time	Total travel time (a) Terminal-to-terminal travel time (b) Access and egress time (c) Waiting time	Travel time to and from teleconference terminal and waiting time*
Service Availability	Availability of service on demand (probability of getting service at desired time, frequency, convenient depature and arrival times)	Availability of service on demand (probability of getting service at desired time)
Comfort and Convenience	Comfort - seating comfort and availability Service reliability - dependability of on-time arrival Changing vehicles (transfer)	Comfort - work space and physical environment Service reliability - reliability of equipment, quality and capability of service

* Time spent in the teleconferencing is not included here. It is considered to be equivalent to that of the face-to-face meeting.

Source: Khan (Reference 23).

Table 7/ User Benefits Arising From Teleconferencing

- Saving of money, time (including personal time).
- Reduction of discomforts (and frustration) associated with travel.
- Improved convenience of communication.
- Improved communication (i.e., more communication and improved effectiveness of communication) for routine tasks and for those tasks that require office resources at hand.
- Improved overall productivity for some employees due to more time available for office work.
- Remotely located employees feel they are part of the corporation.
- Some disbenefits:
  - lack of personal interaction to improve morale, working relationships, etc.
  - lack of recreational or social opportunity at destination
  - frustration with teleconferencing — level of exchange for some tasks is limited.

A survey of existing teleconferencing facilities indicates that a national system of audio teleconferencing exists in Canada. Although there are a certain number of dedicated systems, and a limited number of customer-operated bridges, the system is operator-handled. Considering that the telephone companies obtain only a small portion of their revenues from their existing teleconferencing services, it is hardly surprising that they have not, in general, marketed these services with vigour [35]. This situation is expected to change as a result of competition as more companies get into the supply side of the business.

Factors that would increase public use of audio teleconferencing include further market pull expressed by the private and public sectors, rationalization of a truly dial-up system, rationalization of routing and rate structure, enhanced public awareness through sales and promotion, customer training, improvements in terminal equipment, improvements in bridging arrangements, and provision of speaker identification [35].

Video conference services are on the increase. However, no "on-call" or national system of real-time, two-way video conference is available at present, although there is the capability to arrange a pre-ordered video-conference. Available video conference systems, such as the one offered by Bell Canada between four cities in the Quebec-Windsor corridor, and between Calgary and Edmonton, are underutilized due to lack of technical sophistication and inadequate sales efforts [35].

A major increase in the demand for video conferencing depends upon improved technology, better customer awareness of the value of investment, better customer awareness of the value of quasi-video methods such as slow-scan, facsimile, electronic blackboard, etc., and customer training [35].

References have already been made in this report to the government of Ontario's research and testing endeavours in the teleconferencing area. In recent years, the Ontario government expressed a special interest in this medium as a potential substitute for the face-to-face meetings which involve travel. Reasons for such interest include energy conservation, savings in economic resources devoted to travel, and improved productivity of employees. Test projects were implemented at the Ministry of Transportation and Communications (MTC) and the Ministry of Government Services (MGS). Findings of these projects were judged to be highly encouraging and the TEMP Teleconferencing Task Force, including members of each of these ministries and the Ministry of Energy, was created to promote the use of teleconferencing in Ontario to conserve energy. TEMP provides information, assists in implementation, and conducts research.

In addition to the Ontario government, many other agencies and businesses (Canada and U.S.A.) are using teleconferencing services or have tried these recently. The following examples were selected from a well-maintained file of case studies compiled by TEMP at MTC.

- Air Canada uses teleconferencing every morning to update executives across the country on airline operation.
- IBM Canada has reduced travel through its full-motion video teleconferencing system.
- CMHC (Canada) used teleconferencing when conducting research on housing issues to maintain consistency and to resolve urgent problems.
- Engineers at Ford Motor Company, U.S.A., have used audio teleconferencing and slow-scan video to work out design problems with colleagues in Germany and England.
- Polysar uses audio teleconferencing internationally for sales meetings, technical sessions, and manpower planning.
- 3-M Canada uses audio teleconferencing to support their sales and marketing functions. In addition, it is used extensively to deliver training programs to staff across the country.
- Ford Motor Company, Canada, introduced its 1983 product line to six sites across Canada using multi-point video instead of the traditional "road show".
- The Canadian Science Writers teleconferenced a portion of their annual meeting to delegates across the country.
- Roche Laboratories, U.S.A., uses audio teleconferencing for simultaneous customer training seminars in as many as 100 different locations.

5.2.2/ Office Automation, Electronic Mail, Electronic Funds Transfer

Office automation in technical terms has already been introduced in this report. The cost of equipment and services is already attractive enough for a serious look at this subject. For example, Electronic Information Exchange System (USA) cost is about $25/h. With business satellites in place, a wide variety of electronic mail services will be coming on stream. Some claim that electronic mail has become cheaper than first class mail as a result of recent postal increases in Canada and the U.S.A. It has been suggested that electronic mail may reach 30% of the first class mail volume by 1990 [39]. Bell Northern Research has developed an internal electronic mail system for supporting more than 1200 users and carrying 45 000 messages a month. It is claimed to be totally dependable, available at any time, ready to use and secure [40].

Even today, the mails are impacted by the introduction of facsimile and digital point-to-point transmission systems [41]. Courier companies and Bus Parcel Express report loss of documents traffic to electronic transmission, although urban messenger services are the beneficiaries of such developments.

A number of problems remain in office automation. These include:

- Non-compatible equipment makes it difficult to form networks.
- Management is reluctant to invest in the purchase of equipment since technology is changing fast and equipment becomes obsolete in a short period of time.
- There is a reluctance on the part of office personnal to use the equipment to its potential.
- Natural language queries and commands cannot be handled at present. All advanced equipment, in present form, requires fairly complex protocols for entry into the system (and through the typewriter keyboard) and, sometimes, a limited knowledge of computer language. The use of a "secretary-computer keyboard" combination is costly.
- Further developments in software for office applications are required (e.g., data base management systems, data base design with special emphasis on user-friendly query techniques, messaging, electronic mail, word processing, form processing, integration of services, interactive operating systems).
- User-friendly interfaces are largely absent.
- Technical improvements are needed in the following areas: graphics, storage of high quality images, local area networks, protocols — open system interconnection, and work station and software for the manager.
- Health problems related to the use of electronic work stations are not resolved. These include eye strain, headaches, physiological stress, and psychological stress.

There are also a number of unknowns in office automation research and development areas. These include measures of increased productivity of professional and management workers, needs of office workers for technological aids, the effect of technology on office organization, management of organization change resulting from office automation, and strategy for the implementation of office automation so as to insure user acceptance and positive attitudes.

5.2.3/ Remote Work Centre — Satellite Office

The satellite office concept is here already. Benefits of applying office automation technology to the satellite office in general terms include improved intra-office and inter-office communication (i.e., substitution of electronic media for paper-based communication, easy retrieval) and improved productivity of clerical and possibly managerial staff. Additionally, travel-related and energy advantages are potentially achievable. (See Section 5.4 for energy and other impacts.)

Benefits resulting from satellite office development include:
- saving of money and time resulting from intra-urban substituted travel;
- shorter travel times on less congested routes;
- living and working in a less congested urban setting, yet living close to major centre for special amenities;
- transit service available for journey to work — might even be demand-responsive type of transit;
- reduction of discomfort (and frustrations associated with commuting to downtown of major urban centre);
- regular office environment for personal and professional contacts; and
- improved communication (through telecommunications) with other satellite offices and the central office (i.e., wider technical and human resources become available).

Communication- and transportation-related factors for decentralized offices have been investigated in the U.K., Sweden and the U.S.A. In Canada, only limited applications have been reported (e.g., the Bank of Nova Scotia). In all these cases, the experiments are not comprehensive enough to incorporate all features of a satellite work centre.

In practice, companies may be somewhat reluctant to invest the large sums of money that are implied by more decentralized operations. While it is likely that travel and energy benefits will materialize, the businesses may not be keen to invest capital unless they perceive greater improvements in their efficiency of operation resulting from such investments.

5.2.4/ Home Office

The concept of working at a home office linked by telecommunications with offices has been with us for over two decades. Recently, due to petroleum energy conservation concerns and such technological advances as word processing terminals and computer conferencing facilities, a further interest has been generated in this subject. Bell Canada's Headquarters staff have successfully experimented with the concept in terms of text preparation and problem-solving. In the U.S.A., many test cases have been successful. It is difficult, however, to translate isolated small-scale experiments into a large-scale, potentially successful home work

centre for a broad range of office work. While the advantages of the home office concept are similar to those of the satellite office, user acceptance, even with future availability of low-cost computer terminals, large screen and fibre optics, is an area of substantial uncertainty due to human factors (e.g., disruption of family life, lack of stimulating office environment, etc.). On the basis of the knowledge of the communication needs of office workers, 10 to 20% of workers that make home-based work trips in census metropolitan areas (22 in Canada) could be interested in the home office concept.

5.2.5/ Experience With Substitutes/Case Studies

Teleconferencing in support of business communications has been tried by a large number of organizations. Selected examples have already been quoted in Section 5.2.1. A number of operating teleconferencing systems exist in Canada and elsewhere. Experience gained from such systems is useful in terms of projecting the level of success achievable from teleconferencing as a substitute for travel.

In a recent article by Gold [42], it is stated that out of 11 operational teleconferencing systems reviewed, actual reductions in travel resulted from four services. Three organizations with teleconferencing experience were able to reduce their budgets, and two claimed no reduction in travel during the demonstration of their services. Due to preliminary nature of information on the remaining two systems, an assessment of their experience could not be made.

An evaluation of the teleconference system demonstrations at the Ontario Ministry of Transportation and Communications (MTC) indicates that during an 18-month test period, the dollar value of travel avoided (due to the use of the CNCP Broadband Network) exceeded the cost of audio teleconferencing by a factor of two. MTC claims that the dedicated CNCP Network was generally used to replace essential face-to-face meetings. On the other hand, the use of the flexible Bell Network for shorter conferences permitted more frequent meetings through the electronic medium [9].

The experience of the federal Department of Communications (DOC), reported by Jull, suggests that audio teleconferencing was found to result in significant economic benefits when used to substitute for or complement business trips. Video system costs were estimated to be over 10 times as much as audio systems and were not found to be cost-beneficial [3, 43]. Recent developments, however, suggest that due to declining costs, video systems (including audio/graphic and telewriting) are becoming attractive.

According to the University of Quebec experience, due to constraints on travel (i.e., high cost or management sanctions to reduce travel), employees can be induced to telecommunicate for routine information exchange types of meetings.

The above-selected experiences refer to the use of technology that is more than a decade old. New systems of the future are expected to yield a more promising outcome in terms of their usage and cost-effectiveness. Improved technology, improved designs in terms of their incorporation of human factors, greater availability and convenience of new systems coupled with rising energy and other travel-related costs are expected to yield better results.

5.2.6/ Available User Survey Results

Attitudinal studies of potential or actual users of teleconferencing systems are interesting and informative to review. Although there are negative and inconclusive results obtained in a number of instances, encouraging findings have been reported as well.

Bell (U.S.A.) claims that user attitudes towards a two-way teleconferencing system named Picturephone Meeting Service (PMS) revealed positive attitudes. Yet the cancellation of PMS raises questions about the accuracy of their survey as well as of their marketing efforts [1]. An OECD-sponsored market survey, as well as studies of the Communications Studies Group (U.K.), showed positive attitudes towards teleconferencing for business purposes.

A Bell Canada survey of intercity travellers in the Quebec-Toronto Corridor carried out in 1972 showed that 20% of respondents would not have taken the trip had there been an acceptable telecommunication alternative available. This survey was, however, unable to establish any social characteristics that could be correlated with substitution. Interestingly, travellers wanting to limit their travel were not necessarily those most prone to substitution [24].

User attitude information arising from the Ontario government's audio teleconferencing trials is invaluable for others interested in implementing such services. Prior to the trials, potential users appeared to be reluctant to make use of teleconferencing. Follow-up interviews showed a change in attitudes. Participants that were once reluctant became enthusiastic supporters of teleconferencing [9].

The video conferencing experience of Ontario's Ministry of Government Services (MGS) revealed positive user attitudes. This service, linking Toronto, Ottawa and Thunder Bay, was assessed to be "the next best thing to being there" for such communication tasks as management meetings on projects at various stages in planning, design and implementation, information seminars, medical consultation and patient interviews, and public information sessions [9].

As for the automated office concept, user attitudes are interesting to outline here. According to research supported by the federal Department of Communications, nearly 40% of the completed (office automation) systems which met their functional specifications, do not appear to be well accepted by their users. The cost of these systems represented at least 10 to 15% of the software development budgets of the implementing organizations [45].

Of those systems that were not well received by users, dissatisfaction in over 80% of the cases stems from reasons other than functional incapability. Some problems of user acceptance are [45]:

- difficulty in learning the new system,
- little perceived incentive to use the system,
- perceived lack of security in keeping data confidential,
- difficulty in communicating with system builders,
- resistance to change,
- may not like working with computers, and
- non-conformity to user psychology, sociology and political norm (does not fit the culture).

A number of positive steps can be taken, however, by office automation implementors so as to avoid system failure. These relate to problem-definition, improved project development and implementation process, and improved design of user/machine interface.

5.3/ Other Applications

5.3.1/ Teleshopping

Shopping from home through the use of a catalogue has been practiced for a long time. Telecommunications could replace or supplement this practice in the future. Innovative retailing activities, such as interactive two-way cable TV for ordering merchandise, are being tried. Telidon is being viewed seriously for teleshopping. A question to be addressed here is whether shopping trips that require travel at present could be substituted.

Technology is available for enhancing the scope of teleshopping. Telidon-types of "market place" information and other indexed sources of information are expected to be available in the future. Also, systems for remote on-line order entry and inventory control will become pervasive.

Considering that about 15% of home-based trips are made for "shopping", energy savings and other advantages would materialize should some of these trips be replaced by the communication media. However, the level of such substitution, due to intangible factors (e.g., the feel of an object, shopping as a social diversion) is likely to be small (e.g., 2 to 5% of home-based shopping trips in Census Metropolitan Areas according to References 46 and 47).

A phenomenon associated with telecommunication substitution for shopping trips is that of increased delivery traffic. Also, the use of telecommunications for shopping purposes (e.g. two-way interactive teleshopping) raises the possibility of travel stimulation (e.g., the need to examine the merchandise following a tentative decision through teleshopping). In the absence of real-world experience, the theory of travel stimulation (for shopping) cannot be supported.

5.3.2/ Telemedicine

Telemedicine is a specialized form of teleconferencing for the exchange of medical data, diagnostic information and educating medical personnel. Video systems are used as an aid to examination and diagnosis of patients, and the audio bandwidth is used for transmitting medical data, including x-rays and electro-cardiograms.

A number of telemedicine applications (e.g., radiological consultation with remote Canadian hospitals) suggest a considerable degree of success. Examples include the following:

- The telemedicine project of Memorial University (St. John's, Nfld.) links health and educational institutions throughout Newfoundland and Labrador.

- The Moose Factory General Hospital, which serves Indian and Inuit communities on the shores of James and Hudson Bay was linked on an experimental basis with the Health Services Centre at the University of Western Ontario in London. It was found that in addition to providing a teaching aid, the telecommunications enabled medical staff to employ somewhat more complex procedures.

While the extent of travel for medical training and diagnostic reason is not known, the above-described successful telemedicine activities indicate travel replacement by the electronic media. Due to limited number of trips involved, energy savings are believed to be very small.

5.3.3/ Tele-education (Telecourse)

Telecommunication applications in education include the transmission of course material to students at home, to satellite campuses of an educational institute, to remote locations, and to work locations within an urban region.

Tele-education within a region could save travel for students. For intercity or international telecourse activities, travel by instructors is replaced by telecommunications.

Examples of telecourses are numerous. For instance, in the Ottawa area two universties and a technical college share a cable TV channel for video-based education courses. Examples of long-distance tele-education projects include the following:

- Carleton University in Ottawa and Stanford University in California exchanged courses during a full academic year.

- In Quebec, the scattered campuses of the University of Quebec were integrated into a tele-university.

- In B.C., educational programs were transmitted from Vancouver to Chilliwack, Kelowna and Campbell River.

- The Ontario Educational Communications Authority provides educational opportunities for people living in remote communities.

- Through a joint activity of the federal DOC and the B.C. Ministry of Education, an interactive instructional television network connects ten centres in British Columbia and Whitehorse in the Yukon.

Another application of telecommunications in the area of general education relates to museums. The National Museums of Canada are considering the use of video communications to bring exhibits to communities which would not have the resources, facilities or museum hinterland to attract museum displays. Also, lectures and seminars could be given to interested audiences in other small as well as large communities using telecommunications. These lectures or actual displays could be (two-way) interactive in nature. A "co-operative exercise" is at the planning stage between the National Museums of Canada and Bell Canada for Transpo '86 in Vancouver.

Videotex/Telidon is claimed to have the potential to provide educational experiences for "distance learning". Telidon trials are underway at several colleges and universities in Canada (encouraged through subsidized purchase/lease of equipment). It is believed that Videotex, in association with other telecommunications, could make tele-education an effective and acceptable education medium.

The extra-urban travel impact of tele-education is believed to be very meagre. In large and medium size urban areas, however, about 1% of home-based school (education) trips could be replaced by telecommunications.

5.4/ Impacts of Substituting Telecommunications for Transportation

The direct and indirect impacts of substituting telecommunications for travel include:

- User benefits arising from savings of tangible factors (e.g., time, cost) and intangible factors (e.g., discomfort, inconvenience).
- User disbenefits — lack of personal interaction, lack of social and recreational opportunities at destination, frustration with telecommunications, inconvenience of telecommunications.
- Improved use of transportation infrastructure due to reduction of peak traffic loads.
- Petroleum energy savings.
- Commercialization and promotion cost and time.
- Cost of implementing telecommunications.
- Transportation industry benefits through reduction of peak travel requirement (e.g., reduced fleet size requirements for public transit, taxis, delivery trucks, and courier services).
- Transportation industry disbenefits arising from loss of traffic and associated revenue (e.g., air and rail business traffic).
- Telecommunications industry benefits resulting from increased sales of equipment and services.
- Improved use of telecommunications infrastructure due to increased traffic (e.g., improved use of the capacity of cable TV, fibre optics, and communication satellites).
- Improved environmental quality due to reduced number of polluting vehicles (e.g., automobiles in urban areas).
- Stimulation of the economy through increased telecommunications (the spin-off effects of increased sales of equipment and services).

- Adverse effects on the economy due to possible reduction of transportation vehicles (e.g., automobiles, transit equipment) and services.

- Although it is not strictly an "impact" of such developments, the value of an opportunity will also depend on the usefulness of government involvement in research, development and demonstrations (RD & D) and financial incentives.

The quantification of most of the above-listed impact factors related to the substitution opportunity areas is beyond the scope of this project. On the basis of available information, preliminary estimates of transportation infrastructure impacts and energy savings were developed in this study. These estimates correspond to a saturation level that is likely to occur in the time horizon noted in Table 8. The table shows these estimates as well as commercialization time and diffusion time horizons. Relative impact measures for the remaining factors are shown in Table 9.

In the study of impacts resulting from travel substitution opportunities, the starting point is the nature and extent of substituted travel (e.g., intercity business travel, intra-city work trips). Causal factors involved in influencing travel substitution are discussed in Chapters 3 and 4.

The following methods have been used in assessing the feasibility of substitution:

- Intuitive judgements applied to the various communication needs.

- An analysis of the nature of the communication tasks and face-to-face meeting characteristics.

- Results of psychological studies of the effectiveness and acceptability of telecommunications alternatives.

- Relative attributes of transportation and telecommunications (travel vs telecommunication trade-offs).

- Surveys of travellers, in which respondents were asked to make a hypothetical choice between travel and some telecommunication services (e.g., the Bell Canada survey of intercity travellers).

- Experience with new telecommunications services and user acceptance studies.

The authors believe that teleconferencing may replace up to 25% of intercity business travel by air and rail modes. A lower estimate would be about 5% of business travel substitution. In 1980, 42% of air travel and about 20% of rail travel was stated to be business travel (Transport Canada survey data). Total air travel by national and regional carriers was 23.97 million passenger trips or 39.93 billion revenue passenger-kilometres (Aviation Statistics Centre, Ottawa). The passenger railway mode in 1980 served about 7.4 million intercity passengers or about 2.9 billion passenger-kilometres (Statistics Canada). It is assumed by the authors that inter-urban business trips made by automobile and bus are not substitutable since car and bus modes are chosen for reasons other than speed of travel.

Table 8/ Preliminary Estimates of Selected Impacts

(Comparative Estimates Based on 1980 Base Year)

Opportunity Area	Transportation Infrastructure Impacts --Reduction on Person Trips ($x10^6$)	Petroleum Fuel Saving Litres$x10^6$/yr.	Commercialization Time (Years)	Diffusion Time Horizon
Teleconferening	Air: 0.50-2.52 Rail: 0.07-0.37	Air: 101-504 Rail: 2-10	3-4	1985-90
Remote Work Centre: Satellite Office	Auto: 20-80 Urban Transit: 2-8 Commuter rail: 0.2-0.8	Auto: 36-144 Transit: 0.8-3.2 Commuter rail: small	3-4	1985-90
Remote Work Centre: Home Office	Auto: 24-120 Transit: 2-12 Commuter rail: 0.1-0.4	Auto: 43-216 Transit: 0.8-4.8 Commuter rail: Negligible	4-5	1990-2000
Teleshopping	Auto: 12-30 Transit: 1-3 Commuter rail: Negligible	Auto: 22-54 Transit: 0.4-1.2 Commuter rail: Negligible	4-6	1985-90
Telemedicine	Air: 0-0.023	Air: 0-5	3-4	1985-90
Telecourse	Auto: 0-4 Transit 0-0.4	Auto: 0-7 Transit 0-0.16	3-4	1985-90

Notes: Effectiveness estimates for transportation infrastructure impacts are calculated by using the above data as well as the following:
Air: 1.65¢/passenger-km & average trip length: 1,666 kms.
Rail: No infrastructure cost savings assumed.
Auto: 1.32¢/passenger-km & average trip length of 14.5 kms (urban/regional case).
Urban Transit: No infrastructure cost savings assumed.

Table 9/ Qualitative Assessment of Selected Impacts
(Impacts Assessed in Relative Terms, Range: Very Low to Very High)

Opportunity Areas	User Benefits	Commercialization & Promotion Cost	Implementation Cost	Transportation Industry Benefits	Telecommunication Industry Benefits
Urban/Regional Road Traffic Flow	Positive Medium-High	Low-Medium	Medium	Positive Low-Medium	Positive Medium
Public Transit Information	Positive Medium	Very Low-Low	Very Low	Positive Medium	Positive Medium
Transit Fleet Control	Positive Medium	Low-Medium	Medium	Positive Medium	Positive Medium
Ride Sharing	Positive Medium	Low-Medium	Low	Positve Very Low-Low	Positive Very Low - Low
Freight Transportation & Distribution Management	Positive Medium-High	Low-Medium	Very Low	Positive High	Positive Medium-High
Telecommunications In Urban and Transportation Planning	Positive Low	Medium	Low-Very Low	Positive Very Low	Positive Very Low

Table 9/ Qualitative Assessment of Selected Impacts (Continued)

Opportunity Area	Telecommunication Infrastructure Impact	Environmental Quality	Net Impact on Economy*	Role of Governments
Teleconferencing	Positive High	Positive Low-Medium	Positive--increased telecommunications Negative--loss of transport traffic Net Result: Positive, Low Medium	Medium
Remote Work Centre: Satellite Office	Positive Very High	Positive High	Positive High	Medium
Remote Work Centre: Home Office	Positive High-Very High	Positive Very High	Positive High	Low
Teleshopping	Positive Very Low-Low	Positive Medium	Positive Low	Low
Telemedicine	Positive Very Low	Positive Very Low	Positive Very Low	High
Telecourse	Positive Very Low	Positive Low-Very Low	Positive Very Low	High

* Balance of positive impact on the economy due to increased telecommunications and negative impact arising from loss of transportation carrier traffic.

Two other assumptions are implicit in the above substitution estimates. Firstly, it is assumed that business trips that could be replaced are the same length as those that could not. Secondly, it is believed that "generated" travel induced as a result of developments in telecommunications is zero. This assumption is justified on the grounds that there is little evidence on generated transport traffic induced by increased telecommunications.

Energy impacts of substituting telecommunications for travel are of considerable interest to this project. Although both direct and indirect energy components are involved, only saving of petroleum-based fuels is treated here. In 1980, air transportation consumed 4.6 billion litres of of Turbo fuel and 0.2 billion litres of aviation gasoline [48]. Teleconferencing could save about 504 million litres per year at the 1980 level of consumption.

In the case of rail transportation, up to 11 million litres of diesel fuel could be saved per year. (These savings are related to intercity travel. It is assumed that seat supply is adjusted as a result of substituting telecommunication for travel.) The small magnitude of savings in the rail mode reflects the fact that passenger railway travel in Canada accounts for only about 0.25% of overall Canadian petroleum energy consumption (estimated to be about 108 billion litres in 1980; of this, 54 billion litres are used for transportation) [48].

Totally reliable estimates of travel by automobile are not available. On the basis of Transport Canada's 1980 travel survey and other available information, intercity and rural travel amounted to 114 billion passenger-kilometres per year. Urban travel by automobile in 1980 is estimated by the authors (based on Transport Canada's data) to have been between 8 and 12 billion person-trips or 110 to 170 billion passenger-kilometres. These estimates are based on an average work trip length of 14.5 km for the Census Metropolitan Areas (CMAs) [46, 47].

It has been reported that 80% to 90% of total urban travel is home-based. Out of the total home-based intra-urban trips, 30% are work trips, 15% are shopping trips, and 10% are school (or education-related) trips. On the basis of 10 billion passenger trips, a total of 2.4 billion person-trips, a total of 2.4 billion person-trips are made for journey to work. Of this, about 50% of travel takes place in the 22 CMAs which could be regarded as the only sites of intra-urban travel substitution. As for transit, ridership estimates indicate about 1 billion trips per year for 1980. Commuter train ridership in large metropolitan areas is estimated to be 4.13 million per year (Transport Canada data and Reference 46).

The satellite office concept is expected to primarily reduce passenger-kilometres of travel in CMAs. These reductions are converted here into equivalent work-trip reduction. The ratio of work-trip length in CMA (core plus fringe) /small city or satellite work trip length is estimated to be 1.48. (This is approximated by the ratio of kilometres per capita for commuting by CMA core and fringe area residents/km, per capita for work-trips in small cities [46]).

On the assumption that 5 to 20% of work trips in CMAs could be substituted, the number of such trips can be calculated as shown below:

$$1.2 \times 10^9 \times 0.2 (14.5 \text{ km/trip} - 9.80 \text{ km/trip}) \times (1 + 14.5) = 77.75 \times 10^6$$

The resulting range of substituted (equivalent) trips, is 20 to 80 million trips per year. These trip equivalents amount to 0.2 to 0.8% of urban automobile trips. As for commuter train traffic, it is estimated that 5 to 20% of trips are substitutable.

In 1980, the automobile and light truck (for personal transportation) consumed an estimated 32 billion litres of fuel [48]. Of this total, the authors estimate that travel by automobile and light truck in urban areas consumed 18 billion litres. Fuel savings arising from substituting 0.2 to 0.8% of urban automobile and light truck trips are 36×10^6 to 144×10^6 litres. Urban public transit consumes about 0.4 billion litres (1980 estimate) [48]. Transit fuel energy saving potential is shown in Table 8.

In the case of home work centre, the authors assumed that 2 to 10% of CMA home-based work trips can be substituted. This assumption reflects the basic premise that although in theory up to 20% of commuters could be affected, only about 10% could be regarded as the upper limit for substitution since home office could be acceptable for only one-half of their working days. On the basis of this assumption, 2.5 to 10% of commuter train trips would be substitutable.

The estimated number of substituted trips is 24 to 120 million person-trips, which are equivalent to 350 to 1740 million passenger-kilometres of automobile travel. Substituted trips are calculated to be 0.25 to 1.2% of urban automobile and light truck trips. These substituted trips would result in fuel savings of 45 to 216 million litres.

As stated earlier (in Section 5.2.1), 2 to 5% of home-based shopping trips in CMAs could be substituted by teleshopping. The estimated number of substituted trips per year (at the 1980 traffic level) is 12 to 30 million trips per year.* These represent 0.12 to 0.3% of automobile travel in urban areas. Fuel savings are estimated to be 22 to 54 million litres per year.

Telemedicine is expected to affect only a very small number of air trips. Transport Canada's 1980 travel survey shows that 2.28% of business trips were made by persons who stated medicine to be their occupation. Most of such trips, however, are made in support of the medical profession. It is assumed here that telemedicine would replace up to about 10% of air trips made by the medical profession for business reasons. This results in an estimated 23 000 trips per year (or 0.10% of air travel). Fuel savings are calculated to be up to 5 million litres per year. (These estimates do not include the number of trips made by patients.)

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*Total shopping trips per year =
10 billion trips x 0.5 for CMA travel x 0.8 for home-based trips x 0.15 for shopping trips = 600 million automobile trips.
Substituted shopping trips = 12 to 30 million automobile trips.

Tele-education is expected to have a travel impact in large and medium sized urban areas. As noted in Section 5.2.3, about 1% of home-based school (education) trips in CMAs could be replaced by telecommunications. These amount to about 4 million trips per year. Fuel savings potential is estimated to be up to 7 million litres per year.

Also shown in Table 8 are the commercialization time and the diffusion time horizon for each opportunity area. The commercialization time, in essence, is the number of years required for an interested party or parties to design, implement and assess the success of demonstrations by using the state-of-the-art technology and associated technical software innovations.

The diffusion time horizon is the expected time that an opportunity area requires for widespread application so that it reaches close to the saturation level of implementation. This time horizon applies to all impacts, although the quantifiable impacts are estimated at the 1980 level for relative assessments.

A large number of impacts are expressed only in qualitative terms (Table 9). In addition to showing the direction of the impact (positive or negative), the extent of the impact is shown in the form of a relative value descriptor (i.e., very low, low, medium, high, very high). In Chapter 7, these impact statements are mapped on a relative value scale of 0 to 100 for application in opportunity area assessment.

The impact estimates shown in Table 9 are arrived at subjectively on the basis of their relative effectiveness or effect. For the impact designated as the role of the government, the relative assessments shown are an indication of the extent of the usefulness of governments' involvement. Such involvement is expected to evolve in support of opportunity area promotion, commercialization and implementation activities.

6/ AREAS OF OPPORTUNITY FOR TELECOMMUNICATIONS TO COMPLEMENT TRANSPORTATION

6.1/ Areas of Opportunity and Impacts — General Description

There follows a review of those applications of computer-assisted telecommunication innovations which improve productivity and efficiency of transportation. Through such applications, labour and other costs are reduced and service is improved. Moreover, in some instances computers and telecommunications enable the transportation industry to do things they could not previously do.

"Complementable" transportation activities and operations were identified in Section 3.3. A number of opportunities are described in this chapter for complementing transportation with telecommunications, categorized into the following areas:

- Urban and regional road traffic and driver service improvements.
- Public transit user information services.
- Public transit vehicle/fleet control — location monitoring and dispatching.
- Real-time ride sharing.
- Highway freight transportation and distribution management.
- Telecommunications in urban and transportation planning.

There are, of course, many other areas in which telecommunications applications have already taken place (e.g., pipelines [25]) or are currently being applied at an extensive pace (e.g., air traffic control [25], air cargo management [49], and rail freight car management) [50]. There are still other applications which could be appropriately assessed in future research endeavours. For example, opportunities in the area of safety (i.e., improvements achievable through driver training) and those that support regulations (e.g., storage and retrieval of records on drivers, private and commercial vehicles) have not been included in this study due to their indirect impacts on transportation and also because they are beyond the scope of this project. Additionally, a number of other applications such as highway automation could not be treated in this study due to the scope of this project and the very long-term application horizon of such opportunity areas.

Impacts of complementing transportation with telecommunications are categorized and estimated in a manner similar to those of substitution opportunity areas. Quantitative estimates are developed for passenger trips that are likely to be accommodated due to increased capacity of transportation infrastructure made possible by computer-communication systems.

In the case of highway freight transportation, increased capacity is estimated in the form of truck trips. Also quantified are the likely savings of petroleum. While the transportation infrastructure and energy impacts are favourable, their magnitudes vary considerably depending upon the opportunity area in question. Estimates of commercialization time (years) and diffusion time horizon are developed as well.

6.2/ Telecommunications Complements

6.2.1/ Urban/Regional Road Traffic or Service Improvements

Six interrelated activities or operations can be assisted by telecommunications. These are:

- area-wide network control,
- traffic advisory service,
- freeway ramp metering and surveillance,
- speed limit enforcement and advice, and
- congestion pricing.

Through these measures, road traffic congestion can be eased and flow of traffic can be improved, since such measures reduce stop-and-go driving and long periods of engine idling. Measures which improve traffic flow result in energy savings, safety improvements, reduced motorist's travel time, improved environmental quality, and efficient roadway capacity utilization (implying possible deferral of capital expenditure for new roadway capacity). For the improvement of the overall urban transportation system, these measures should be undertaken in association with public transit and ride-sharing system improvements [51].

Computerized traffic control systems monitor traffic flow and remotely adjust traffic signal cycles and offsets for achieving smooth traffic flow throughout an urban area. The technology of centralized traffic signal control systems is well developed and has been applied around the world. A number of Canadian cities have already implemented such systems. Currently, a growing number of Ontario municipalities are adopting such systems (e.g., the city of Brantford and the regional municipalities of Waterloo and Durham are installing computerized traffic control systems). Computerized traffic control systems can save up to 20% of the energy consumed by any traffic directly affected* [51]. These systems are cost-effective for cities of 50 000 or more [51].

Computer-communication assisted traffic control systems use two-way communications link between traffic signals and the centrally-controlled facility. For this purpose, public telephone lines can be used or private lines can be installed.

Other technologies of interconnection include the application of laser systems (e.g., Atlanta), packet radio technology, and the use of cable TV facilities [52].

A second means of improving road traffic is a system that incorporates telecommunications to monitor road conditions and advise drivers of congestion, accidents, etc. on the route. Drivers can be informed of alternative routes to destinations by wayside variable message signs, highway advisory radio, or in-vehicle displays. Thus traffic bottle-

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*Urban auto travel is about one-half of all auto travel. Fuel consumed by automobile and light van travel in urban areas amounted to about 18 billion litres in 1980.

(Source — Estimated from information contained in a paper compiled by the Energy Planning Directorate, Transport Canada, Mayes R.R. and W.F. Johnson, "Planning for Transport Fuel Use in the 1980s," (1982)).

necks, delays and accidents can be avoided by distributing traffic over many routes, and travel speed can be improved. The energy saving potential of such systems has been assessed by the authors to result in a 6% saving in fuel consumption of the traffic affected.

A number of systems based on Highway Advisory Radio are in existence. Congestion data, collected from traffic sensors and closed circuit TV cameras, are transmitted to a central operator who, in turn, advises drivers about road traffic conditions. Comprehensive automobile traffic control and electronic route guidance systems are at the development and demonstration stages. The Japanese Agency of Industrial Science and Technology of the Ministry of International Trade and Industry is testing such integrated systems [53]. As for the cost-effectiveness of such systems, recent studies for the Federal Highway Agency (U.S.A.) suggest potential cost and energy savings for localized urban applications [16].

A third means of improving road traffic involves freeway ramp metering and surveillance which attempts to avoid congestion on freeways. The technology for such applications is sufficiently advanced for application in major urban areas where extreme congestion problems are encountered [16]. A range of ramp metering sytems can be implemented depending upon the cost and capacity. MTC has experience in this area due to projects in the Metropolitan Toronto Area [54]. Energy conservation impact has been estimated by other investigators to be 8 to 10% of traffic affected [16, 51].

Speed limit enforcement and the provision of travel speed advice can be carried out through telecommunications. The technology is available for automatically monitoring the speed and identity of automobiles as well as for related communications and data processing needs. Actual applications to their full capability have not been reported [16].

A related concept is that of reducing speed variations from the optimal average for energy conservation and other reasons. Experience with variable speed controls in England and Germany suggest higher traffic volumes are obtainable, plus a reduction in the number and severity of accidents.

Automobile traffic congestion in urban centres could be reduced through charging tolls for entry at different times of the day. While this concept of a congestion pricing system has been in existence for many decades, implementation was not possible due to limitations of technology. Today, however, communications and computer technologies can be used to identify vehicle entry into and exit from high-density areas and to automatically bill the users.

A system with all the necessary capabilities is expected to go into operation in Hong Kong in 1987. Such a system would consist of a transponder in each vehicle, electronic signposts (receiver-transmitters) strategically located in the urban area, communications devices, and a data processing centre. The energy saving potential of this concept has been estimated at about 1% of fuel consumed by urban automobile trips affected [16].

6.2.2/ Public Transit User Information Services

Public transit user information services are required in three service contexts:

- bus stops,
- public transit terminals, and
- the information needs of handicapped persons.

Firstly, the need for information at bus stops along fixed routes occurs due to lack of knowledge about schedules and the uncertainty of bus arrival times. The use of telecommunications to monitor bus travel time (i.e., position along route) relative to its schedule and to transmit this information to homes and/or scheduled stops (through telephone or displays indicating time of next bus arrival) is found to result in increased patronage. Main technological features include an automated bus location system and a computer-generated voice system. Aside from the satisfaction of user information needs, automatic bus locating systems also result in improved security and improve schedule adherence and, consequently, attract more bus users.

Examples of such systems include the "Easy Rider" system (Mississauga) and the "560" system (Ottawa-Carleton Transit Commission).* The "Easy Rider system, developed by Tele-Rider Corporation of Toronto, tracks the position of each bus along a route; the current location of all buses is updated in the computer data bank together with the estimated time of arrival (ETA) at various stops ahead on the routes. Extensions that are under consideration include the capability to provide passenger counts, announcements about the probability of obtaining a seat, and linkage to the bus dispatch system [26, 55, 56].

Extensions to the Ottawa "560" system are expected as well, including computer selection of the most appropriate combination of routes to make a desired trip, bus transfer schedule for each particular stop, and "real-time" information through "560".

Other potential developments include display of information at the appropriate busy downtown stops which would identify the buses in order and with expected arrival times (e.g., next bus at this stop, Route 27, in 4 minutes) [7, 26]. Additionally, in the future, a large variety of services could be offered through interactive cable TV (at home) for different purposes than current systems offer (e.g., a user requesting the status of buses and other transit systems from home, expanded automated computer systems). The combination of a bus monitoring and interactive cable TV systems could provide a powerful service to transit riders of the future [7].

In public transit terminals, travellers often experience disorientation due to lack of information about arrival and departure stalls (platforms) and times. Automated transit information systems (such as DOVER, the Netherlands [27]) can be developed for terminals that provide up-to-the-minute information about bus movements in a terminal area to the users and the management (Figure 2). In such a system, a vehicle detection and

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*Hardware and software costs totalled: $810 000 in the first year of implementation, $625 000 in Year 2, and $625 000 in Year 3 [57].

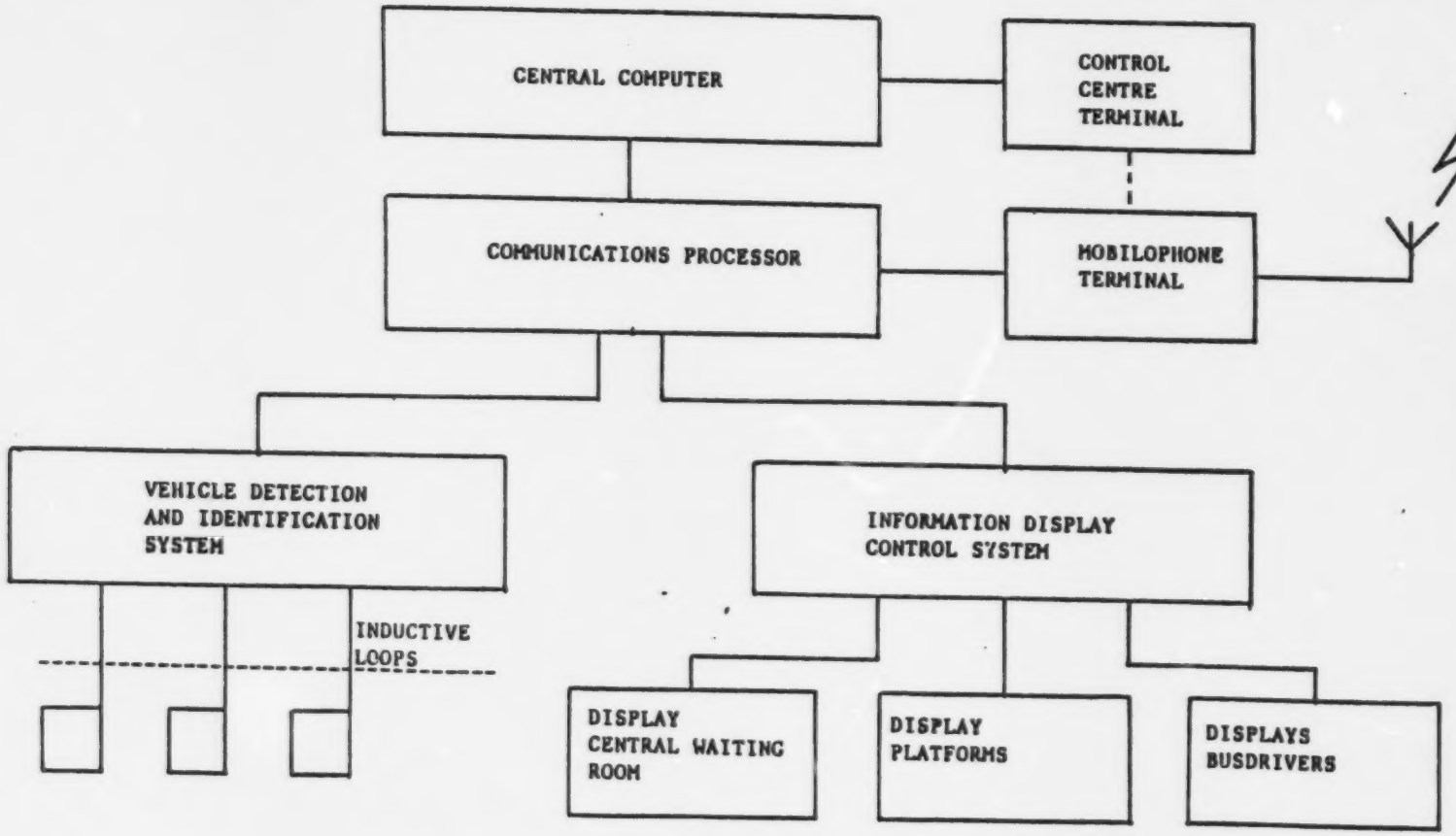

Figure 2/ The DOVER System

identification device collects data about bus movements and transmits this infromation to a processing computer. With possible intervention from the control centre staff, the computer allots the buses to the platforms and informs travellers, drivers, and control centre staff of departure times and platforms. Communication technology could also assist public agencies to provide transit information to handicapped persons.* Due to the extensive nature of the subject, no attempt is made here to discuss developments in this area.

Automated public transit information systems have energy saving potential since a significant proportion of new travellers attracted to transit are in fact diverted from the automobile. In the case of Ottawa's "560" system, a 2.8% overall ridership increase (and 8.2% in the off-peak periods) was attributable to the information system. It has been estimated that each route information call generates five trips per year [55]. Also, an estimated 1.1 million litres of fuel are saved per year due to travel diversion from the automobile in the Ottawa-Carleton Region [55, 56]. Another kind of energy saving, although very modest, results from the function of the bus location system that causes the bus system to be more efficient and reduces the number of vehicles required to provide the same level of service [16].

6.2.3/ Transit Vehicle Fleet Control — Location, Monitoring and Dispatching

The function of user information systems can be viewed as being separate and distinct from the management function of fleet control in terms of location monitoring and dispatching. Automatic vehicle location systems improve security and schedule adherence.

The automatic vehicle locating system is an assembly of technologies and equipment that permits centralized and automatic determination, display and control of the position and movement of multiple vehicles throughout an area. Automatic vehicle position and movement determination is usually accomplished by a process of inquiry and response, initiated and controlled from the central control facilities [58]. Fixed route public transit and random route fleet dispatching operations are potential metropolitan area users of automatic vehicle location technology.

Automated bus monitoring and communication systems can be used to:
- determine actual bus position, compare it to scheduled position and send results to scheduled stops;
- reduce the extent of poor bus schedule adherence and reduce fleet size;
- eliminate passenger inconvenience in the case of en route equipment breakdowns;

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* See, for instance, the Toronto Transit Commission's telephone information for the deaf — The Visual Ear — which makes it possible for those with speech or hearing impairments to telephone for transit information using a special keyboard.

- determine the number of passengers on board [59]; and
- detect faulty bus maintenance through microprocessor technology coupled with telecommunications which can permit key performance parameters (i.e., idling speed, fuel consumption rates, engine speed, temperature, etc.) to be monitored remotely and potential malfunctions or breakdowns to be predicted prior to their occurrence [16].

Other functions of transit vehicle fleet control system are those of scheduling and dispatching of vehicles. Computer-aided scheduling and related tools are developing rapidly in North America. The new generation of methods are mostly interactive in nature. The impact of new methods is expected to be beneficial for the transit industry because of reduction in transit operating costs as well as greater ease of use and other benefits accruing from convenient availability of a computerized data base [60].

There is considerable experience with computerized dispatching. For instance, Blue Line Taxi Company of Ottawa has one of the best computerized dispatching systems in the field (see Figure 3). The advantages of such advanced systems include faster and more accurate dispatching, better public relations, improved controls and discipline in dealing with the drivers, more management information availability, and fewer personnel involved in dispatching and control activities.

Computerized and radio-controlled dispatching for demand-responsive types of transit fleets (e.g. para-transit) is expected to be enhanced with developments in mobile radio systems, mobile satellite radio systems, integrated digital networks and cellular systems.

It is possible that in the future, a flexible transit system will evolve which will be a compromise between dial-a-bus and fixed route systems. Dial-a-bus services are expected to continue for the handicapped. It should be possible to develop various intermediate demand-responsive systems which have some characteristics of a fixed route system and some of the features of a dial-a-bus system. In such a system, service to specific bus stops would be requested (in a manner similar to the current practice) and the users might be taken to a destination stop or an interchange point such as a commuter or a subway station [7]. Concepts for such systems exist, and these may compare favourably in economic terms with conventional transit [7].

Energy savings and other benefits accrue from the application of fleet control techniques. Reasons include:

1/ increased efficiency of the bus system, thereby reducing the number of vehicles (up to 5%) required to provide the same service;
2/ operating buses closer to their optimum operating point;
3/ diverting urban travellers from the automobile to public transit due to improved convenience and reliability of service; and
4/ reduced need to operate replacement buses and reduced towing.

Estimates reported in the literature suggest that about 5% of transit energy could be saved annually due to reason number 2 listed above.

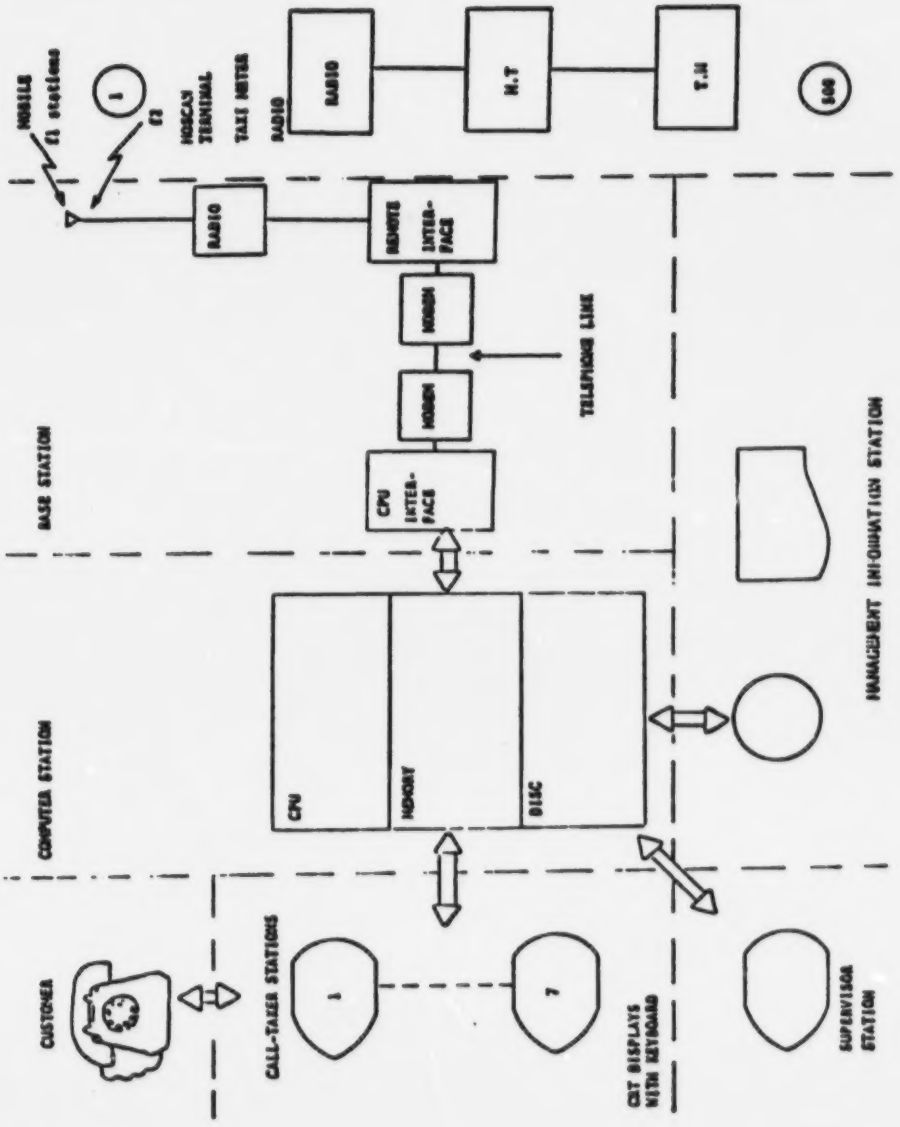

Figure 3/ Computer Dispatch System

6.2.4/ Ride-Sharing Service

Ride-sharing in the form of van- and car-pooling is a reasonably well accepted transportation concept in Canada and the U.S.A. The growing number of van-pool and car-pool projects for peak period travel suggests that such concepts could be useful in off-peak periods as well. In support of such concepts, ride-sharing centres are required in urban areas to co-ordinate demand (persons wanting to ride) with supply (persons willing to drive their automobile or a van) on a real-time basis. Information could be received and transmitted through telecommunication means (i.e., telephone, interactive cable TV of the future).

Present car pools and van pools do not operate on a real-time basis. The demand and supply cannot be matched on a dynamic basis since at any time people who are about to drive cannot find out about those in the vicinity in need of a ride.

The methodology required to implement and operate real-time ride-sharing services are similar to those of para-transit services such as dial-a-bus and shared-ride taxi cab. The scope for (computer-communication based) automated information systems increases considerably for large urban areas. Experience is at hand in the development of automated dial-a-bus and shared-ride taxi cab control systems [16, 61].

The implementation of ride-sharing services could result in energy savings (estimated to be about 1% of automobile fuel consumption in off-peak periods) and other benefits (e.g., reduction of road congestion). Impacts on public transit services are not expected to be noticeable since users of such services are expected to be diverted from the automobile, although energy-intensive taxi operations could be impacted. The implementation of ride-sharing services requires an investigation of insurance and liability issues. Experience with real-time ride-sharing and resolution of insurance and liability problems could be invaluable in the case of severe energy supply constraints.

6.2.5/ Freight Transportation and Distribution Management

The availability of new information technology now makes it possible for highway freight transportation and distribution activities to improve their productivity [6, 64, 65]. The growing importance of this sector of the transportation industry makes it essential that every opportunity should be explored to modernize its activities and operation. According to the Canadian Association of Physical Distribution Management, about $50 billion is spent each year in Canada on the elements of physical distribution (namely transportation, warehousing, production and inventory planning, customer services and administration). Order processing, customer service and physical distribution management accounted for 13% of total distribution costs.

Computer-communications technology could be of assistance in the following operations:

- Dynamic inventory of shipments, containers and vehicles (tractors, trailers, pick-up and delivery vehicles).

- Updating and transmission of data about shipments.
- Scheduling, dispatching and communication with collection-distribution (C-D) vehicle fleet.
- Assignment of loads to vehicles when both loads and vehicles are widely dispersed and much information has to be updated over short intervals of time.
- Multi-station message requirements.
- Automatic billing, management reports, and cost accounting.
- Transportation rates information to customers.

Traditional applications of communication systems in this sector of transportation included communications with C-D vehicles through radio. Recent developments such as the computerized system developed for Federal Express (a U.S.-based courier company) embraces all operations from order taking to tracing misrouted items. The Federal Express information system is currently being extended to their trucks which are being equipped with display terminals connected to the computer via mobile radio [70].

Another development that has already been tested is the Data Freight System of British Road Services [71]. This is a computerized system of storing and updating information about the location of cargo that needs to be moved and vehicles that are available to carry them.

Recent surveys and studies show that, in general, the use of computer-communication systems is growing in this industry [66, 67]. Sophisticated computer-communication networks have been developed and implemented in support of physical distribution functions [68]. Specific capabilities and applications include:

- processing of waybill data;
- administrative message switching (i.e., point-to-point messages, group messages including all-points bulletins, message resend and reroute capability;
- provision of expected arrival times of shipments, while in transit;
- monitoring and control of shipments from pick-up and delivery including retaining all status changes involving each and every shipment, and data on operations such as forwarding, trans-shipment and delivery;
- monitoring equipment control, reporting and handling of inquiries;
- provision of intermodal information about equipment status; and
- on-line rating, preparation of accounting reports and invoices.

There are also less sophisticated and very inexpensive systems that are already in service for administrative support, production of statistics for management functions and customer information services [69].

Future developments include improved physical distribution operations through better communications and simulations of load plans for line-haul operations, electronic data interchange of freight bill information to the customer (i.e., the accounts receivable bill is sent electronically, not on paper), automatic bank transfer (electronic funds transfer), transfer of "bill of lading" data directly from customer's computer to carrier's computer, and computerization of rates.

In addition to achieving productivity improvements, computer-communication applications (described above) to the entire industry could save energy in trucking operations.

6.2.6/ Telecommunications in Urban and Transportation Planning

The urban planning process and its essential component of transportation planning have a substantial impact on travel patterns and associated energy requirements. Professionals responsible for such processes have not up to now recognized the role of telecommunications in enabling the achievement of a selected urban form. It is desirable that telecommunications should be treated explicitly as a mode of communication at the planning stage of transportation systems. Energy savings and other benefits could be achieved that would not necessarily occur if substitution and complementarity opportunities were allowed to evolve without explicit planning.

6.3/ Impacts of Opportunity Areas

Direct and indirect impacts of telecommunication complements to transportation are, in general, encompassed by those described in Section 5.4 for the substitution opportunities. From the long list of impacts, those that do not apply in the present case include user disbenefits, transportation industry disbenefits, and adverse effects on the economy.

Preliminary estimates of selected quantifiable impacts are presented in Table 10. This table also shows the commercialization time (years) and diffusion time horizon. Transport infrastructure impact is noted in the form of passenger trip equivalents (that can be accomodated as a result of improved capacity) or truck trips (that can be accommodated for transporting more freight due to improved utilization of existing fleet). The implication here is that of a gain in the transportation infrastructure's capability to accommodate extra traffic without physical expansion of the facilities. Available information suggests that in 1980, a total of 10 billion urban person-trips were made by the automobile and 1 billion person-trips were served by urban public transit (based on Transport Canada estimates). Of the total person trips, about 50% of travel takes place in CMAs [46]. The authors estimate that road traffic improvements will result in a 0.5 to 2% capacity increase in the Census Metropolitan Areas.

Public transportation information is assessed by the authors to improve transit ridership by 1 to 5% in the CMAs. It is assumed that three out of five new travellers using transit are diverted from the automobile. Thus fuel savings accrue due to modal shifts. Also, improved adherence to schedules results in fuel savings on the order of 0.5 to 2.5% of transit fuel use in the CMAs. Transit fleet management is also expected

Table 10/ Preliminary Estimates of Selected Impacts
(Comparative Estimates Based on 1980 Base Year)

Opportunity Area	Transportation Infrastructure Impact -- Increased Capacity	Petroleum Fuel Saving$_6$ Litres x 10^6/yr.	Commercialization Time (Years)	Diffusion Time Horizon
Urban/Regional Road Traffic Flow	Pass. trips Auto: 25-100x10^6 Transit 2.5-10x10^6	Auto: 45-180 Transit: 1-4	3-4	1985-90
Public Transit Information	Transit 5-25x10^6 Pass.trips*	Auto: 5-27 Transit: 1-5	2-3	1985-90
Transit Fleet Control	Transit 5-25x10^6 Pass. trips**	Auto: 2-9 Transit 2-10	2-3	1985-90
Ride Sharing	Auto: 5-25x10^6 Pass.trips	Auto: 9-45	3-4	1990-95
Freight Transportation & Distribution Management	Truck: 0.04-0.2x10^6 truck trips	Truck 58-230++	2-3	1985-90
Telecommunications In Urban and Transportation Planning	Auto: 2-10x10^6 Pass.trips	Auto: 3.6-18	3-4	1990-2000

* Assume that 3 out of 5 passenger trips are diverted from the automobile.
** Assume that 1 out of 5 passenger trips is diverted from the automobile.
++ Based on saving of 0.5 to 2% of truck's fuel consumption per year.

Notes: Effectiveness estimates for transportation infrastructure impacts are calculated by using the above data as well as infrastructure cost/passenger-km and average trip length (in kms.). For truck transportation, estimates of savings in infrastructure are developed as noted in text. See footnotes to Table V.4 for air, automobile, and urban transit.

to result in transit capacity and ridership improvements of 1 to 5% in the CMAs. In this case, one out of five new transit passenger trips is assumed to be diverted from the automobile. Fuel saving in transit systems of CMAs are estimated to be 1 to 5% of urban public transit's annual fuel consumption. These savings arising from improved operations are additional to fuel savings resulting from the diversion of automobile users to the transit system.

Ride-sharing is assumed to affect 0.1 to 0.5% of automobile trips in Census Metropolitan Areas. Freight transportation and distribution management innovations, the authors believe, are likely to improve operations and eliminate 0.04 to 0.2 million truck trips per year which amount to 0.5 to 2.0% of total truck trips per year. Telecommunications in urban and transportation planning may increase infrastructure capacity which could amount to 0.04 to 0.2% of automobile trips per year in Census Metropolitan Areas.

Out of 18 billion litres of fuel consumed by automobile and light truck users (for personal transportation in urban areas at the 1980 level of consumption), road traffic flow improvements are expected to result in fuel savings of 45 to 180 million litres (0.25 to 1.0% of 1980 automobile fuel consumption in urban areas). For urban transit, which consumed 0.4 billion litres of fuel in 1980, the expected reduction in fuel used ranges from 0.2 to 1.0%.

Public transit information services, ride sharing, and telecommunications in urban and transportation planning result in fuel savings that reflect ridership effects noted above. In the case of freight transportation and distribution management, savings of 0.5 to 2% of truck transportation fuel are expected.

In 1980, fuel consumption by the trucking sector amounted to 11.5 billion litres.

Also noted in Table 10 are the commercialization time estimates and the diffusion time horizon for each complementarity opportunity area.

Qualitative estimates of non-quantifiable impacts are presented in Table 11. Both the direction of the impacts (i.e., positive) and the relative extent of their effect are noted.

Table 11/ Qualitative Estimates of Selected Impacts

(Impacts Assessed in Relative Terms, Range: Very Low to Very High)

Opportunity Areas	User Benefits	Commercialization & Promotion Cost	Implementation Cost	Transportation Industry Benefits	Telecommunication Industry Benefits
Urban/Regional Road Traffic Flow	Positive Medium-High	Low-Medium	Medium	Positive Low-Medium	Positive Medium
Public Transit Information	Positive Medium	Very Low-Low	Very Low	Positive Medium	Positive Medium
Transit Fleet Control	Positive Medium	Low-Medium	Medium	Positive Medium	Positive Medium
Ride Sharing	Positive Medium	Low-Medium	Low	Positve Very Low-Low	Positive Very Low - Low
Freight Transportation & Distribution Management	Positive Medium-High	Low-Medium	Very Low	Positive High	Positive Medium-High
Telecommunications In Urban and Transportation Planning	Positive Low	Medium	Low-Very Low	Positive Very Low	Positive Very Low

Table 11/ Qualitative Estimates of Selected Impacts (Continued)
(Impacts Assessed in Relative Terms, Range: Very Low to Very High)

Opportunity Area	Telecommunication Infrastructure Impact	Environmental Quality	Net Impact on Economy*	Role of Governments
Teleconferencing	Positive High	Positive Low-Medium	Positive--increased telecommunications Negative--loss of transport traffic Net Result: Positive, Low Medium	Medium
Remote Work Centre: Satellite Office	Positive Very High	Positive High	Positive High	Medium
Remote Work Centre: Home Office	Positive High-Very High	Positive Very High	Positive High	Low
Teleshopping	Positive Very Low-Low	Positive Medium	Positive Low	Low
Telemedicine	Positive Very Low	Positive Very Low	Positive Very Low	High
Telecourse	Positive Very Low	Positive Low-Very Low	Positive Very Low	High

* Balance of positive impact on the economy due to increased telecommunications and negative impact arising from loss of transportation carrier traffic.

7/ TECHNIQUES FOR ASSESSING OPPORTUNITY AREAS

7.1/ Assessment Requirements and Criteria

The problem at hand is to establish a hierarchy of opportunity areas in the order of their desirability for further research, development and demonstrations. In this chapter, methods of assessing opportunity areas (including criteria) will be discussed and a demonstration of two such methods will be presented using analyses contained in Chapters 5 and 6.

It is recognized in this research that the task of assessing opportunity areas should take into account:

- most if not all concerns of the interest groups including the government, expressed as criteria for assessment,
- relative importance of assessment criteria expressed as criteria weights,
- the uncertainty of criteria achievement under each opportunity area resulting from:
  a) imperfect knowledge of user acceptance of opportunities for substitution or complementarity,
  b) assumptions about transportation costs and inconvenience, and
  c) assumptions about telecommunications technology (cost, performance and availability).

A number of assessment criteria have already been presented in Chapters 5 and 6. They were defined in terms of the values, goals and objectives of the interest or impact groups. These include the following:

Interest Group.	Concerns of the Interest Group
Government & Users	• Telecommunications and transportation user benefits (time, cost, comfort and convenience, other intangible concerns such as perceived concerns related to status, effectiveness & productivity)
Governments	• Petroleum-based energy saving • Environmental quality • Efficient use of transportation infrastructure (capacity improvements, reduced requirements for physical expansion) • Efficient use of telecommunications infrastructure • Impacts on the economy (spin-offs) • Commercialization time (timeliness of achieving results) • Implementation costs — economic resources that are needed above the commercialization stage which the governments may spend in order to assist in the widespread implementation of the initiative.
Transportation Industry	• Transportation industry benefits/-disbenefits — financial impacts on commercial carriers, crown corporations and other transportation agencies.
Telecommunications Industry	• Benefits (profits) from sales of technology and services.

Users of services, and governments on behalf of users, are interested in inducing positive benefits from a change in their communication and transportation services, and avoiding disbenefits. Governments are also interested in achieving, as soon as possible, goals of petroleum fuel conservation, environmental quality, efficient utilization of transportation and telecommunications infrastructure, and stimulation of the economy with minimum expenditure of public funds. Exercising an appropriate role in transportation-telecommunications interrelationships is believed to be a valid concern of governments.

The transportation industry is interested in avoiding adverse effects in the form of ridership losses and in enhancing their efficiency and productivity. On the other hand, the telecommunications industry is logically interested in maximizing sales of equipment and services.

An incorporation of these concerns in the opportunity area assessment is to be carried out in the form of 12 evaluation criteria. Table 12 lists these as well as their measure of effectiveness.

Criteria measures, as defined here, vary from quantifiable variables to specially defined relative measures (i.e., very high effectiveness, high effectiveness, etc.). For each criterion, methods of assigning relative values include impact estimates developed in this research project, literature sources, and the judgement of the study team. That is, subjective value estimates are based on the information presented in Chapters 5 and 6 and technical knowledge (of the evaluators) of the numerous facets of the transportation and telecommunications sectors. As this study is intended to assess opportunities in a preliminary fashion, macro level comparisons are believed to be appropriate for research in this field.

(A word of caution — In reviewing the results of a preliminary study of this type, the reader should be aware of its limitations. That is, when comparing general areas of opportunity there is a risk of overlooking a promising specific opportunity classified in an area that is not highly rated in general.)

It is logical that decision-makers (evaluators) would be interested in expressing the relative importance of each criterion in the assessment of opportunity areas. Relative weights assigned to the assessment criteria are an expression of the values and goals of the decision-making body. In this project, for the purposes of illustration, relative weights were assigned by the study team.

Criteria attainment level estimates can be appropriately expressed in the form of single values or as a range of values. While single value estimates are preferrable since these permit the use of simple assessment methods, a range of values reflects the difficulty of arriving at point estimates. Uncertainty of users' attitudes to computer-telecommunication innovations and the lack of precise estimators can be taken into account in the form of assigning subjective probabilities.

For all criteria listed in Table 12 except cr_9 (transportation industry benefits), the relative value scale of 0 to 100 can be used to show the effectiveness of each opportunity area in achieving the criteria. In the case of cr_9 however, the relative value scale covers both disbenefits and benefits. That is, zero refers to maximum disbenefits, a value of 50 means no benefits or disbenefits resulting from the opportunity implementation, and a scale value of 100 is used for maximum benefits.

7.2/ Assessment Techniques

Six methods may be used for evaluating or assessing alternatives. These can be referred to as:

- Pros and cons method
- Economic efficiency methods
- Cost-effectiveness method
- Goal achievement (or overall effectiveness) methods
- Expected-utility method
- Delphi technique

The "pros and cons" method requires an examination of positive and negative impacts (i.e. criteria attainment estimates or subjective statements). The evaluators express their judgement on the basis of the raw information about the candidate initiatives or opportunity areas. Input statements in most instances are likely to be subjective statements of positive or negative effects covering a wide range of concerns. As an illustration of impact statements that could form the basis of the "pros and cons" method, the reader is advised to examine user benefits arising from teleconferencing as presented in Table 7.

Table 12/ Criteria and Measures of Effectiveness

	Criterion	Measures of Effectiveness
cr_1	User Benefits	Relative values or scores, estimated on a scale of 0-100, for each opportunity area on the basis of changes in money, time, comfort, convenience and other intangibles which would accrue to users as a result of services affected.
cr_2	Efficient Use of Transportation Infrastructure	Relative values or scores estimated for each opportunity area on the basis of its impact on infrastructure (capacity) utilization (i.e. increased throughput, opportunity to accomodate more traffic) (see Tables 8 & 10).
cr_3	Efficient Use of Telecommunications Infrastructure	Effectiveness of an opportunity area to improve the utilization of the capacity of telecommunication facilities and networks, measured on the relative value scale.
cr_4	Petroleum Fuel (Energy) Saving	Potential saving of energy if the opportunity area is adopted — relative values derived from actual estimates presented in Tables 8 & 10).
cr_5	Environmental	Environmental quality improvement due to reduction of polluting vehicles, expressed in relative values between 0 and 100.
cr_6	Commercialization Time (to be minimized)	The number of years required to bring the opportunity area to a stage for wide-scale promotion and implementation (but not including implementation time), mapped on the relative value scale.
cr_7	Commericalization Promotion Cost, Borne by Governments	Relative value estimates reflecting and economic resources that are required to achieve typical potential users' acceptance.
cr_8	Implementation Cost	Relative value estimates of economic resources that are needed (above the commercialization and promotion costs) which the municipal, provincial and federal government agencies must spend (directly or indirectly as tax incentives) to implement the opportunity

Table 12/ Criteria and Measures of Effectiveness (Continued)

	Criterion	Measures of Effectiveness
		area (e.g. MTC's assistance to municipalities for computerized traffic control, tax incentives to private industry related to the implementation of technologies in "satellite office" or "home office" concepts).
cr_9	Transportation Industry Benefits	Relative value estimates of the benefits/disbenefits (i.e., the contribution or impact of opportunity area to transportation industry's profits/-losses). The relative value scale in this case is used to show positive benefits as well as disbenefits — 0 for maximum loss and 100 for maximum gain.
cr_{10}	Telecommunications Industry Benefits (equipment, supplies, service providers)	Relative measures are developed on the scale of 0 to 100, which reflect benefits resulting from opportunity and area implementation.
cr_{11}	Stimulation of the Economy	Relative values assigned on the basis of opportunity area potential in inducing net economic spin-offs.
cr_{12}	Role of Government — to maximize the opporunity of playing a role in transportation-telecommunication interrelationship	Relative values assigned on the basis of the nature of opportunity area (in terms of public vs. private sector roles) and the effectiveness of useful government involvement.

Clearly, most items listed in Table 7 (e.g., discomforts and frustration associated with travel, convenience of communications, remotely located employees feel part of the corporation, etc.) can only be expressed in the form of desirability or undesirability statements. A somewhat more condensed type of information is arranged in Tables 8, 9, 10 and 11.

The advantage of the "pros and cons" method of assessing opportunity areas is the richness of information available to the evaluators. Since quantification of the impacts is not a necessary requirement, there is generally little reason to exclude highly subjective information or to assign a rating to these (e.g., ratings of very high, high, medium, low, and very low on an orginal scale). The disadvantages include the difficulty of comparing alternatives due to the numerous criteria involved and the complexity of assigning weights (informally) to the assessment criteria.

The economic efficiency approaches, used for estimating the economic returns obtainable from investment alternatives, require measuring all costs and benefits on a dollar value scale. The results of these approaches are expressed in the form of benefit/cost ratio, present or equivalent annual value of net benefits, and internal rate of return [72, 73, 74]. Due to a large number of impacts that cannot be quantified in dollar terms, the economic efficiency approaches cannot be used for the assessment of opportunity areas of interest in this report without sacrificing much detail.

The cost-effectiveness approach, on the other hand, permits an assessment of multiple criteria achievement potential and maps these against economic costs (e.g., demonstration costs, investment in permanent facilities, etc.) [73]. The basic philosophy and methodology in assessing the effectiveness of opportunity areas is the same as that used in the goal achievement (or overall effectiveness) methods discussed below.

The cost part of this approach requires the estimation of initial and future investments required for the opportunity areas under consideration. In the context of this research, since the development of costs is beyond the scope of this project, the cost-effectiveness approach cannot be implemented.

The goal achievement (or overall effectiveness) approaches define all evaluation criteria (including costs) on a relative value basis and calculate an overall effectiveness score for each alternative by incorporating probabilities of criteria satisfaction [72]. Since these approaches are recommended for application in this research, they are discussed below in detail.

The expected utility approach requires the development of utility functions (curves) for costs and effectiveness criteria and requires the application of probabilities for variables that are uncertain in nature [74, 75]. This method, as well as the goal achievement and cost-effectiveness methods described above, enable the decision-makers to assign weights to the evaluation criteria.

While the expected utility approach is conceptually attractive, the development of utility functions requires substantial research efforts involving interviews with potential users of computer-communication

systems and decision-makers who commit resources in such systems. Additionally, considerable difficulty is involved in estimating/assigning probabilities associated with consumer acceptance of computer-communication systems, technological and cost forecasts. The use of this method for the preliminary assessment task to be performed in this research is not feasible due to extensive data requirements.

Finally, the Delphi technique has been frequently used over the past two decades for the evaluation of new products or services that involve much uncertainty [77]. Through the use of this method, informed concensus of opinions for predicting future conditions is established. The Delphi technique has been of assistance to a number of professional groups such as market planners, policy planners, systems researchers and long-term business planners.

A typical Delphi study design includes the following steps:

- Search of the literature describing previous applications of Delphi to similar assessment problems.
- Assembling a panel of experts (and/or user groups if applicable).
- Development and pre-testing of a questionnaire.
- Implementation of a revised questionnaire.
- Statistical analysis of first-round answers and analysis of supporting estimates and comments from panel members.
- Designing, pre-testing and implementation of second-round questionnaire (while showing summaries of first-round results to the panel and asking for resolution of answers within the panel).
- Final analysis of questionnaire results.

To demonstrate the application of the Dephi technique is beyond the scope of this research. However, in Chapter 8, the technique is recommended for future research endeavours.

In the case of multi-criteria approaches, a number of specific techniques are available for weighting the evaluation criteria. These include ranking, rating, and methods of successive comparisons [72]. For the type of problem at hand, which could require participation of a number of persons (judges), and which requires the incorporation of a reasonable number of evaluation criteria, ranking and rating techniques (for criteria weighting) are suitable.

The criteria ranking method requires that each member of the judging panel place a raw rank for each criterion in the list. In the case of the criteria rating technique which is recommended for this project, a numerical type of rating scale is used but descriptions are not associated with the integer points on the numerical scale. The list of criteria to be weighted are placed in a column adjacent to a scale marked in units continuously from ten to zero (top to bottom). A rating of zero indicates that there is no value associated with a given criterion and a

rating of ten is the highest that may be assigned to any criterion. Integer or non-integer position may be assigned to a criterion on the rating scale.

Criteria weights can be calculated from the following information:

$$w_j = \frac{V_j}{\sum_{j=1}^{n} V_j} \qquad (j = 1,2,\ldots,n)$$

$$V_j = \sum_{\ell=1}^{q} V_{\ell j}$$

where: n is number of criteria
q is number of judges
w_j is weight established for criterion j
$V_{\ell j}$ is the rating assigned to criterion j by judge.

The next requirement for the assessment technique that is recommended for this study, namely the goal achievement (or overall effectivness) method, is that of incorporating the uncertainty (risk) associated with the criteria achievement estimates for the opportunity areas. This can be expressed as the probability of success in achieving the criteria attainment level in question (e.g., relative value estimate of energy saving) [16]. In the case of a range of relative value estimates, discrete values of probability or probability distributions can be assigned [74].

In support of the recommended methodology, the role of the various actors and their information requirements should be understood. In theory, the technical experts are required to estimate the criterion attainment levels and the probabilities. Each member of a panel of technical experts could be asked to develop independent estimates of criterion attainment levels and the probabilities. Alternatively, such a panel could jointly develop one set of effectiveness and probability estimates.

Technical experts would be generally assisted by the information contained in this report. Specific information that would serve as a guide to technical experts includes analysis of opportunity areas (Chapters 5 and 6) and a description of the assessment criteria (Chapters 5, 6 and 7). Other useful information would include additional material describing opportunity areas (if available), and a list of relevant "external factors" as suggested in Chapter 4.

In order to be effective, the panel of technical experts should include persons knowledgeable about the areas covered by the assessment criteria. It is logical to expect that members of the panel would be specialists in well-defined opportunity and impact areas (e.g., teleconferencing, user benefits, efficient use of transportation infrastructure, external impacts such as those on the economy, etc.).

A team of experts with specialized knowledge would develop effectiveness and probability figures as these relate to specific impact areas. On the other hand, a different panel of experts could be assembled whose members would feel confident enough to develop the entire set of criteria attainment and probability estimates. A final set of figures could be synthesized from the responses of the panel members.

The remaining information item, namely criteria weights, due to value judgements involved, are to be assigned by "policy experts". In support of this task, the panel of policy experts would require a list of opportunity areas being judged, the kind of evaluation methodology to be used in general and criteria weighting technique in particular, and the intended use of the final ratings of opportunities (e.g., to support research decisions, pilot project decisions, decisions related to government support of private initiatives, etc.).

The application of goal achievement models described below results in ratings for each opportunity area. On the basis of these rating scores, a hierarchy of opportunity areas can be established which would reflect an order of desirability. A high rating achieved by an initiative would reflect a high level of weighted criteria achievement that is expected to materialize should that initiative be implemented. The weighting of expected level of criteria achievement is based on the relative importance of the criteria.

Logically, opportunity areas with high scores should be assigned a high priority by the agency conducting or sponsoring the assessment process. Depending upon the purpose of the assessment task, an agency such as MTC might wish to take steps such as assigning high priority to such research areas in terms of allocating research budgets, and identifying specific opportunities within these highly rated initiatives.

Goal Achievement Model 1

The goal achievement or effectiveness model which combines the evaluation parameters (discussed above) in order to produce a rank order of opportunity areas is given below:

$$E(a_i) = \sum_{j=1}^{n} w_j \cdot e^*_{ij}$$

$$e^*_{ij} = p(e_{ij})$$

where: $E(a_i)$ is the overall effectiveness score of an opportunity area a_i for $i=1,2,\ldots,m$

m is number of opportunity areas

w_j is criterion weight

e_{ij} is the expected effectiveness of a_i in achieving criterion j (Please see Section 7.3 for the development of e_{ij} estimates).

e^*_{ij} is the relative value estimate of effectiveness of a_i in achieving criterion j

P is the probability of success of a_i in achieving the e_{ij} estimate

The application of this model implies that a probability of no success (i.e., 1-p) is applied to zero level of criterion achievement.

Goal Achievement Model 2

This model differs from the one shown above only in respect of its capability to treat a range of relative value estimates.

$$E(a_i) = \sum_{j=i}^{n} w_j \cdot e^*_{ij}$$

$$e^*_{ij} = p_1 (e_{ij1}) + p_2 (e_{ij2}) + \dots + p_k (e_{ijk})$$

or in the case of working with two extreme values

$$e^*_{ij} = p_1 (e_{ij1}) + p_2 (e_{ij2})$$

where: $E(a_i)$ is the overall effectiveness score of an opportunity area a_i

w_j is criterion weight

e^*_{ij} is the expected effectiveness of a_i in achieving criterion j

e_{ij1}, e_{ij2} are a range of estimates of opportunity area effectiveness in respect of criterion j

p_1, p_2 are probabilities of achieving e_{ij1} and e_{ij2}, respectively

p_1+p_2 + probability of "no success" = 1.0 or in case of k values of e_{ij},

$p_1+p_2+\dots+p_k$ + probability of "no success" = 1.0

or in case of k values of e_{ij},

$p_1 + p_2 + \dots + p_k$ + probability of "no success" = 1.0

7.3/ Demonstration of Selected Assessment Models

7.3.1/ Model 1

The assessment techniques recommended for this project(described in Section 7.2) require, as the first step, a weighting of the criteria. Two evaluators were assumed to define raw weights for the 12 criteria developed in this chapter (see Table 13). These weights were assigned from the viewpoint that energy saving is the most important criterion,

Table 13/ Criteria Weights
(Example Assessment)

	Criterion	Raw Weights (0-10 Scale) Evaluator 1	Evaluator 2	Normalized Criteria Weights
cr_1	User benefits	6	6	0.12
cr_2	Efficient Use of transportation infrastructure	5	5	0.10
cr_3	Efficient use of telecommunications infrastructure	4	5	0.09
cr_4	Petroleum fuel (energy) saving	10	8	0.18
cr_5	Environmental quality	1	1	0.02
cr_6	Commercialization time	4	4	0.08
cr_7	Commercialization and promotion cost	4	4	0.08
cr_8	Implementation cost	4	4	0.08
cr_9	Transportation industry benefits	4	3	0.07
cr_{10}	Telecommunications industry benefits	3	3	0.06
cr_{11}	Stimulation of the economy	3	3	0.06
cr_{12}	Role of government	3	3	0.06
				1.00

followed, by user benefits, and efficient use of transportation infrastructure. It was also assumed that telecommunication industry benefits would be weighted somewhat lower than other criteria since it is a relatively new industry enjoying healthy growth and profits. Other assumptions made are reflected in relative weights assigned to the criteria.

The raw weights assigned by two evaluators are normalized into fractions which total 1.0 (see Table 13). In practice, a large number of policy experts could set the raw weights.

The second step in the application of the first assessment model involves the development of criteria achievement values on the scale of 0 to 100. These values as well as associated subjective probabilities of their occurrence (success) are shown in Tables 14 and 15. The relative values shown in these tables reflect (preliminary) upper-limit estimates developed for efficient use of transportation infrastructure, energy savings and commercialization time. These estimates are presented in Tables 8 and 10. The transportation infrastructure impacts are transformed into relative values on the basis of infrastructure cost.*

For the remaining criteria, even preliminary estimates of their achievement could not be developed since many "softer factors" are involved that are non-quantifiable. On the basis of the impact statements presented in Tables 9 and 11, relative values of criteria attainment are assigned.

In the present illustrative example of the use of assessment method, a single set of criteria attainment values and probabilities of success are used. In practice, a number of evaluators could assign their values of criteria achievement as the associated probabilities. From these, average values could be developed.

In the final step, the use of assessment technique allows the evaluator(s) to combine the information presented in Tables 13, 14 and 15 in order to arrive at the final scores for the opportunity areas. The results of the illustrative example are tabulated in Table 16. The final effectiveness scores lead to the ordering (ranking) of opportunity areas.

7.3.2/ Model 2

The essential difference between this model and Model 1 is the treatment of a range of criteria achievement values and the assignment of probabilities to the two extreme value sets as well as to zero achievement level. That is, the total probability of 1.0 is spread over two extreme values of criteria attainment and the event of "no success". It should be noted that in some cases, a criteria attainment value could be zero due to the mapping of the impacts on 0 to 100 scale. Tables 17, 18 and 19 show the input to the model and results arising from the application of the model.

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* Estimated from information presented in Tables 6.4 and 6.6 of Reference 76 and average trip lengths. For road freight, a saving of 0.5 to 2% of infrastructure cost attributable to trucks is assumed.

The results shown in Tables 16 and 19 reflect the inputs to the assessment process. As previously noted, the analysis of opportunity areas and the criteria achievement level estimates developed in Chapters 5 and 6 are based on a combination of realistic information acquired in this project and the judgement of the authors based on their knowledge of the subjects involved. The weighting of the criteria, although far from arbitrary, is nevertheless intended for the demonstration of the assessment techniques.

Finally, a few comments would be useful here regarding the two models demonstrated in this chapter. The input requirements of Model 2 are much more extensive since a range of criteria attainment estimates can be accomodated in the model. Due to the different inputs, including probability estimates, it is logical that the end results from the two models are not identical. On the other hand, there is a lack of dramatic differences in ranking using Model 1 versus Model 2. This can be explained by referring to the common rationale and theory of the models. While Model 1 requires single estimates of criteria achievements, Model 2 allows the treatment of ranges of estimates. Since the difference is basically in the level of detail, the results of such models should not be dramatically different.

A logical question here is whether Model 2 is worth the extra effort. The answer to this question depends upon the quality of data, and the degree of uncertainty perceived by the technical experts. Should the experts feel confident about single-value estimates and their associated probabilities, then in such a situation, Model 1 is the appropriate choice.

Table 14/ The Effectiveness of Substitution Opportunity Areas: Example Assessment No. 1

Relative Values (0 to 100 Scale) and Probability of Success

Opportunity Area	cr_1	cr_2	cr_3	cr_4	cr_5	cr_6	cr_7	cr_8	cr_9	cr_{10}	cr_{11}	cr_{12}
Teleconferencing	60 (0.40)	100 (0.40)	80 (0.40)	100 (0.40)	60 (0.40)	75 (0.50)	60 (0.50)	60 (0.50)	20 (0.40)	80 (0.40)	60 (0.40)	60 (0.50)
Remote Work Centre: Satellite Office	80 (0.40)	22 (0.40)	100 (0.40)	29 (0.40)	80 (0.40)	75 (0.50)	40 (0.50)	60 (0.50)	40 (0.40)	100 (0.40)	80 (0.40)	60 (0.50)
Remote Work Centre: Home Office	100 (0.30)	33 (0.30)	100 (0.30)	43 (0.30)	100 (0.30)	50 (0.40)	40 (0.40)	60 (0.40)	40 (0.30)	100 (0.30)	80 (0.30)	40 (0.40)
Teleshopping	40 (0.30)	8 (0.30)	40 (0.30)	11 (0.30)	60 (0.30)	25 (0.40)	40 (0.40)	40 (0.40)	50 (0.30)	40 (0.30)	40 (0.30)	40 (0.40)
Telemedicine	20 (0.50)	1 (0.50)	20 (0.50)	1 (0.50)	20 (0.50)	75 (0.50)	80 (0.50)	80 (0.50)	40 (0.50)	20 (0.50)	20 (0.50)	80 (0.50)
Telecourse	40 (0.40)	1 (0.40)	20 (0.40)	1 (0.40)	40 (0.40)	75 (0.50)	80 (0.50)	80 (0.50)	40 (0.40)	20 (0.40)	20 (0.40)	80 (0.50)

Table 15/ The Effectiveness of Complementarity of Opportunity Areas:
Example Assessment No. 1

Relative Values (0 to 100 Scale) and Probability of Success

Opportunity Area	cr_1	cr_2	cr_3	cr_4	cr_5	cr_6	cr_7	cr_8	cr_9	cr_{10}	cr_{11}	cr_{12}
Urban/Regional Road Traffic Flow	80 (0.6)	28 (0.6)	60 (0.6)	36 (0.6)	60 (0.6)	75 (0.6)	80 (0.6)	80 (0.6)	75 (0.6)	60 (0.6)	60 (0.6)	100 (0.6)
Public Transit Information	60 (0.4)	4 (0.4)	60 (0.4)	6 (0.4)	40 (0.4)	100 (0.6)	100 (0.6)	100 (0.6)	75 (0.4)	60 (0.4)	60 (0.4)	100 (0.6)
Transit Fleet Control	60 (0.5)	1 (0.5)	60 (0.5)	4 (0.5)	20 (0.5)	100 (0.6)	80 (0.6)	60 (0.6)	75 (0.5)	60 (0.5)	60 (0.5)	100 (0.6)
Ridesharing	60 (0.4)	7 (0.4)	20 (0.4)	9 (0.4)	40 (0.4)	75 (0.4)	80 (0.4)	80 (0.4)	60 (0.4)	40 (0.4)	20 (0.4)	60 (0.4)
Freight Transportation & Distribution Management	80 (0.5)	61 (0.5)	60 (0.5)	45 (0.5)	60 (0.5)	100 (0.5)	80 (0.5)	100 (0.5)	100 (0.5)	80 (0.5)	80 (0.5)	60 (0.5)
Telecommunications in Urban and Transportation Planning	40 (0.4)	3 (0.4)	20 (0.4)	4 (0.4)	20 (0.4)	75 (0.4)	60 (0.4)	100 (0.4)	55 (0.4)	20 (0.4)	20 (0.4)	80 (0.5)

Table 16/ Opportunity Area Rank and Final Score
Example Assessment No. 1

Rank	Opportunity Area	Effectiveness Score
1	Urban/Regional Road Traffic Flow Improvement	37.64
2	Road Freight Transportation and Distribution Management	36.50
3	Teleconferencing	30.96
4	Public Transit Information	28.93
5	Public Transit Fleet Control	28.26
6	Remote Work Centre: Satellite Office	25.29
7	Remote Work Centre: Home Office	20.05
8	Telecourse	16.95
9	Real Time Ride Sharing	16.93
10	Telemedicine	16.84
11	Telecommunications in Urban and Transportation Planning	15.63
12	Teleshopping	10.52

Table 17/ The Effectiveness of Substitution Opportunity Areas: Example Assessment No. 2

Relative Value Range (0 to 100) and Associated Probabilities*

Opportunity Area	cr_1	cr_2	cr_3	cr_4	cr_5	cr_6	cr_7	cr_8	cr_9	cr_{10}	cr_{11}	cr_{12}
Tele-conferencing	40-60 (0.25)	20-100 (0.25)	60-80 (0.25)	20-100 (0.25)	20-60 (0.25)	50-75 (0.25)	40-60 (0.25)	40-60 (0.25)	0-20 (0.5)	60-80 (0.25)	20-60 (0.25)	40-60 (0.25)
Remote Work Centre: Satellite Office	60-80 (0.25)	6-22 (0.25)	80-100 (0.25)	7-29 (0.25)	60-80 (0.25)	50-75 (0.25)	20-40 (0.25)	40-60 (0.25)	20-40 (0.25)	80-100 (0.25)	60-80 (0.25)	40-60 (0.25)
Remote Work Centre: Home	60-100 (0.25)	7-33 (0.25)	60-100 (0.25)	9-43 (0.25)	80-100 (0.25)	25-50 (0.25)	0-40 (0.5)	20-60 (0.25)	20-40 (0.25)	60-100 (0.25)	60-80 (0.25)	20-40 (0.25)
Tele-shopping	20-40 (0.25)	3-8 (0.25)	0-40 (0.5)	4-11 (0.25)	40-60 (0.25)	0-25 (0.5)	20-40 (0.25)	20-40 (0.25)	20-50 (0.25)	0-40 (0.5)	20-40 (0.25)	20-40 (0.25)
Tele-medicine	0-20 (0.5)	0-1 (0.5)	0-20 (0.5)	0-1 (0.5)	0-20 (0.5)	50-75 (0.25)	60-80 (0.25)	60-80 (0.25)	20-40 (0.25)	0-20 (0.5)	0-20 (0.5)	60-80 (0.25)
Tele-course	0-40 (0.5)	0-1 (0.5)	0-20 (0.5)	0-1 (0.5)	0-40 (0.5)	50-75 (0.25)	60-80 (0.25)	60-80 (0.25)	20-40 (0.25)	0-20 (0.5)	0-20 (0.5)	60-80 (0.25)

* The difference between 1.0 and the sum of probabilities for non-zero criteria achievement values is the probability of "no success".

Table 18/ The Effectiveness of Substitution Opportunity Areas: Example Assessment No. 2

Relative Value Range (0 to 100) and Associated Probabilities*

Opportunity Area	cr_1	cr_2	cr_3	cr_4	cr_5	cr_6	cr_7	cr_8	cr_9	cr_{10}	cr_{11}	cr_{12}
Urban/ Regional Road Traffic Flow	40-80	7-28	40-60	9-36	40-60	50-75	40-80	40-80	60-75	40-60	40-60	80-100
	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)	(0.3)
Public Transit Information	40-60	1-4	40-60	1-6	20-40	75-100	60-100	80-100	60-75	40-60	40-60	80-100
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.3)	(0.3)	(0.3)	(0.3)
Transit Fleet Control	40-60	0.3-1	40-60	1-4	0-20	75-100	40-80	40-60	65-75	40-60	40-60	80-100
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.5)	(0.3)	(0.3)	(0.3)	(0.3)
Ride Sharing	40-60	1-7	0-20	2-9	20-40	50-75	40-80	60-80	50-60	0-40	0-20	40-60
	(0.25)	(0.25)	(0.5	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.5)	(0.5)	(0.25)
Freight Transportation & Distribution Management	40-80	16-61	40-60	11-46	40-60	75-100	40-80	80-100	75-100	40-80	40-80	40-60
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
Telecommunications in Urban & Transportation Planning	20-40	1-3	0-20	1-4	0-20	50-75	40-60	60-100	50-55	0-20	0-20	60-80
	(0.25)	(0.25)	(0.5)	(0.25)	(0.5)	(0.25)	(0.25)	(0.25)	(0.25)	(0.5)	(0.5)	(0.25)

* The difference between 1.0 and the sum of probabilities for non-zero criteria attainment values is the probability of "no success".

Table 19/ Opportunity Area Rank and Final Score
Example Assessment No. 2

Rank	Opportunity Area	Effectiveness Score
1	Urban/Regional Road Traffic Flow Improvement	29.54
2	Road Freight Transportation and Distribution Management	28.43
3	Public Transit Information	26.96
4	Teleconferencing	26.95
5	Remote Work Centre: Satellite Office	24.33
6	Public Transit Fleet Control	23.88
7	Remote Work Centre: Home Office	23.81
8	Real Time Ride Sharing	17.82
9	Telecourse	16.29
10	Telecommunications in Urban and Transportation Planning	16.06
11	Telemedicine	14.89
12	Teleshopping	12.67

8/ RECOMMENDATIONS

8.1/ Uses of This Report

This report presents two major components of the research undertaken by the investigators. These are:

1/ The identification and analysis of 12 opportunity areas for the use of telecommunications to substitute for, or complement transportation.

2/ The definition of techniques for the assessment of opportunity areas, including a demonstration of selected assessment techniques, based on information generated in the first component of this research.

Both components of this research go beyond previous studies in terms of enhancing the state of knowledge. The Ministry of Transportation and Communications (Ontario) and other interested departments and agencies could gainfully use the information reported here in support of government decision-making.

Specifically, Chapters 3 and 4 provide a rationale and supporting information for the analysis and evaluation of opportunity areas. Chapters 5 and 6 cover the analysis of 12 areas of opportunity, including impacts that would occur as a result of their implementation. An insight into the subject of techniques to assess the relative desirability of opportunity areas is provided in Chapter 7. The strengths and weaknesses of the various techniques are discussed and illustrative applications are provided for selected techniques.

The immediate application of this research is in planning for further research and development activities. However, in the absence of extensions to this research in terms of further refinement of the opportunity areas, or even in the absence of in-house assessments by MTC, the initiatives that received high scores (in Chapter 7) may be designated for demonstrations or financial support. As a note of caution, it should be recognized that the opportunity area ranks shown in Chapter 7 (Tables 16 and 19) reflect criteria weights assigned by the study team.

By way of organizing other recommendations arising from this study, two major categories of future actions are described below. Further research is recommended in those aspects of the interrelationship of transportation and computer-communication systems where currently available information is judged to be deficient. Another type of future action that might be taken involves the application of assessment procedures by the MTC.

8.2/ Future Research

Item 1

Further insights are required for the understanding and delineation of "substitutable" communication needs and "complementable" transportation activities and operations. In this respect, further research could

explore in detailed terms a large number of initiatives, including those that have been covered in this research within the scope of the study. By way of example, teleconferencing, and highway freight transportation and distribution management could be cited among those initiatives that require further research.

Due to the scope of this research study, activities such as transportation safety and information needs in support of transportation regulations could not be covered. Future endeavours in these areas would require supplemental detailed information.

Also, analysis of the opportunity areas and their impacts could be strengthened through future research. Additionally, future studies could focus on the identification and analysis of sub-opportunity areas such as various modes of teleconferencing. Furthermore, a number of impacts could not be quantified due to the scope of the present study. Future research could, for instance, attempt to estimate commercialization and promotion costs, and implementation costs of various opportunity areas.

Item 2

The influence of selected major factors on the transportation-telecommunications interrelationship is covered in this report.
Factors researched include:

- transportation technology in terms of service and cost, land use and spatial factors;
- communications technology including capability, cost and planning and institutional factors.

Since new developments in these factors in general and communication technology in particular are likely to occur at a rapid pace, future efforts should monitor such developments and their influence on transportation-telecommunication interrelationship. Furthermore, future efforts could look into those relevant influences that could not be treated here due to the scope of this study. A list of such factors is contained in Section 4.1 (e.g. the economy).

Item 3

Further basic research in the following areas would enhance our knowledge of the transportation-computer communications interrelationship:

- trade-offs between travel and telecommunications;
- stimulation of travel due to enhanced telecommunications;
- communication and travel characteristics of selected business traveller groups;
- the structuring of human communications by computer-communications technology;
- operational efficiencies in conducting work through the use of telecommunications in lieu of travel;
- the role of communications technology in inducing the decentralization of offices in large metropolitan areas;
- "readiness factors" for the acceptance of substitution type of initiatives and "enabling forces" that serve as catalysts (these should include technological, human, institutional, marketing and regulatory policy factors); and
- further innovative applications of technology such as the use of cable (fibres) technology in providing transportation information at home.

Item 4

Further research could also be undertaken in the form of a more detailed study of selected opportunity areas (or sub-areas within these) with different scenarios and prediction of impacts. As noted below in Section 8.3, such research could be initiated through the application of a modified Delphi technique for technological forecasting and assessment of opportunities.

8.3/ Further Procedures and Resource Persons

Further Procedures

Further work could also be initiated on the techniques and procedures for assessing opportunity areas. These could include a real-world application of one of the goal achievement models demonstrated in this study. As discussed in Chapter 7, such a procedure would require the formation of a panel of technical experts as well as a panel of policy experts. Technical experts could be provided with the material generated in this study on the impacts of opportunity areas (Chapters 5 and 6). This material could thus be used by the technical experts as the starting point. Likewise, the panel of policy experts could gainfully utilize information generated in this report. A discussion of the roles and activities of these panels has already been provided in Chapter 7.

A variety of opportunity assessment activities could be carried out through the use of goal achievement techniques. These include the following:

- Separate assessments of areas of opportunity for the substitution and opportunities for complementing transportation could be carried out.

- A different list (than developed in this study) of opportunity areas and assessment criteria could be used. Future researchers might wish to concentrate on a longer list of initiatives combined with a shorter list of quantifiable criteria.

The above-noted applications of the goal achievement techniques could be used for:

- narrowing the list of pilot projects with well-defined goals/objectives/criteria and budgets;

- making a choice between exploratory research and/or development studies with well-defined goals/objectives/criteria and budgets;

- making a choice between industry initiatives seeking government support; and

- creating a hierarchy of options in terms of their desirability in any one of the above choice areas but with a smaller number of explicitly defined assessment criteria.

Other future activities in the area of assessment techniques could include use of the expected utility approach and the Delphi technique. The difficulties in implementing the expected utility approach (as outlined in Section 7.2) outweigh those of the Delphi technique. It is believed by the research team that future endeavours could gainfully utilize the Delphi technique for the evaluation of computer-communication initiatives. Such an approach could include the following steps:

- search of literature describing previous assessment of alternatives;
- assembling panel of experts;
- developing and pretesting of questionnaire;
- implementation of revised questionnaire;
- statistical analysis of first-round answers;
- analysis of supporting comments;
- designing, pre-testing and implementation of second-round questionnaire; and
- preparing final consensus of results.

Resource Persons:

In addition to consulting university-based experts, the following persons could be contacted for updates of information and expert opinion on the subject(s) noted.

Mr D.M. Atkinson (Teleconferencing, Remote work location)
Director, Long-Range Planning
Bell Canada
160 Elgin Street
Ninth Floor
Ottawa, Ontario

Mr R. Evans (Electronic mail, Remote work location)
Electronic Mail Task Force
Canada Post
Billings Bridge Shopping Centre
Office Tower
Sixth Floor
Ottawa, Ontario

Mr P. Homulos (Teleconferencing)
National Museums of Canada
240 Bank Street
Ottawa, Ontario

Mr K. Hoyle (Telecommunications technology, telecommunication substitutes for travel, office of the future, human factors)
Assistant Vice-President
Long-Range Policy
Bell Canada

Dr G. Jull (Teleconferencing)
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Research Psychologist
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(Human factors, office automation)

Mr M. Steers
Information Services
Telesat Canada
333 River Road
Vanier, Ontario

(Telecommunications technology)

Mr O. Walker
Senior Systems Analyst
Glengarry Transport
Alexandria, Ontario

(Applications of computer-communication systems in physical distribution and management)

9/ SUMMARY

Background

The purposes of this study are:

i) to identify opportunities for the substitution of telecommunications for transportation and complementing transportation with computer-communication systems, and

ii) to contribute information for the assessment of opportunity areas.

Telecommunications as a substitute for or complement to transportation is becoming attractive for a number of reasons including increased cost of transportation, reduced cost and enhanced technological capabilities in computer-communication, and micro-electronic systems.

There are existing examples of telecommunication systems that, according to published reviews, are already serving as means to avoid travel and/or as alternatives to travel [1, 2, 3, 4]. Additionally, the applications of computer-communication systems to enhance the efficiency of transportation activities and operations are on the increase [5, 6, 7].

A number of urban and regional teleconference centres have been in existence for over a decade. In recent years, more teleconference facilities have been planned or established.

Examples are numerous. Related developments in the form of office automation, electronic mail and telecourses are well underway. In a number of instances, telecommunication systems, according to literature references, are already helping business and government departments (especially those that are decentralized) to save money and avoid the many inconveniences of travel [8, 9]. Also, medical [10], educational [11], and social [12] activities are already beneficiaries of such developments. Furthermore, desirable impacts are likely to occur such as energy savings and improved usage of transportation infrastructure during peak times. While some believe that the process of substituting telecommunications for travel has already begun [8, 9], most researchers believe that general acceptance of telecommunication substitutes for travel is expected to come about in a gradual manner [13, 14, 15]. There is also the question of travel stimulation from increased telecommunication system developments and their use by potential travellers.

Identification of areas of opportunity for the substitution of telecommunications for travel and monitoring consumers' travel substitution (and possible stimulation) are appropriate research topics from strategic long-term planning and social research perspectives for both the transportation and telecommunication sectors. Successful results could be ensured if a sound conceptual framework is established for research, development and demonstrations including impact assessments.

The other facet of the transportation-telecommunications interrelationship is that of the use of computer-assisted communication means to complement transportation. Application of computer-communication innovations in transportation can be regarded as another frontier for improving the efficiency and productivity of transportation systems. It is contended that computer-communication systems are going to be topics of rapidly increasing importance in all aspects of the transportation indus-

try since their applications, whenever judged to be feasible, could enable cost control through productive use of labour and other resources, and could also result in service improvements and possibly increased usage of public modes and enhanced revenue [5, 6, 7].

Over the next decade, telecommunications and computers could gainfully affect almost every segment of the transportation industry. Applications of these technologies will alter the modus operandi, as we know it, of transportation today (e.g., scheduling, dispatching, control). They will also, to a considerable degree, enable us to carry out new activities that are not carried out at present (e.g., communication with passenger and freight vehicles in an extensive way). It is essential that opportunities in this area of research are identified and utilized. Considering Canada's advanced high technology industry, much of it in Ontario, it is imperative that Canada should be second to none in developing and using computer-telecommunication innovations to complement transportation.

An examination of available information including previous research sponsored by the Ministry of Transportation and Communications, Ontario [17] suggests that further research is required for the development of an improved conceptual foundation for future (R & D) projects designed to identify and assess specific opportunities for substitution of communications for transportation and the use of communication systems in support of transportation. Also, it is desirable that a wider range of opportunities be identified for future research.

Research Approach

At the outset of this project, research objectives were defined in detailed terms. These are reported in Chapter 1. A research framework consisting of eleven work plan items was then established for the investigation of transportation-telecommunications interrelationships (Figure 1). In the design of this study framework, a broad perspective of communication needs was used to arrive at those tasks which offer the potential to substitute telecommunications for travel. Similarly, a comprehensive effort led to the opportunity areas for complementing transportation with telecommunication systems. Chapter 2 reports the framework for this research.

Following a review of literature and previous lists of opportunities, the "substitutable" communication needs by purpose, and interest groups, and "complementable" transportation activities and operations were defined (see Chapter 3). Major factors that affect the use of telecommunications as a substitute for or complement to transportation are discussed in Chapter 4. These include the transportation, land use and geographic factors (i.e., urban structure, urban/rural, Canada-U.S.A., and East-West), and communications technology, planning and institutional factors. These factors, in essence, could largely influence potentially successful applications of computer-communication systems in lieu of travel or as complements to transportation.

Areas of opportunity for the use of telecommunications to substitute for transportation were defined next. In addition to their categorization and analytical treatment, the impacts of substitution means were investigated (see Chapter 5). Similarly, areas of opportunity for the use of

telecommunications to complement transportation were identified and appropriate impact factors were assessed (Chapter 6).

As an aid to the assessment of the potential and desirability of opportunity areas, assessment requirements, criteria and techniques were required. Chapter 7 reports these. Also, a demonstration of selected assessment techniques was carried out which is presented in Chapter 7.

Recommendations are reported in Chapter 8 for further research including procedures for the delineation of attractive research areas. Also, included is a list of resource persons who could be consulted for future research endeavours.

References cited in the text are listed following Chapter 8 in the order in which these are referred to in the text. The annotated bibliography presented at the end of the report contains literature that relates to the various facets of the project.

Study Findings

The following two observations summarize the general findings of this study.

1/ Recent developments in computer-communications technology in terms of enhanced technical capability, capacity and reduced cost and size have allowed computer-communication systems to offer acceptable quality of message while being affordable and convenient. On the other hand, transportation costs have been perceived to be rising given service quality. Both in the public and private sector, there is much pressure to improve transportation productivity and efficiency. Since these trends are expected to continue, the topics of substituting telecommunications for travel and complementing transportation with computer-communication systems will assume considerable importance.

2/ Massive uncertainties in respect of user acceptance, further technological developments (in hardware and software), future course of policies and regulations, and general economic conditions do not permit precise forecasting and evaluation of opportunity areas. Guessing the future on the basis of meagre information is fraught with risks. Consequently, probable future success of substitution and complementarity type of opportunity areas is assessed on the basis of available data supplemented by subjective but informed judgement. The implication of this and the above general finding is that the topic of this study should be researched and monitored on an on-going basis and information support for opportunity area evaluation should be continuously improved. Recommendations are contained in the report for further research in order to improve our understanding of the uncertainties and also of assessment procedures for the identification of most desirable opportunities.

Findings of this study that relate to specific facets of the subject covered are summarized below.

1/ Identification of opportunities to substitute telecommunications for travel requires the delineation of substitutable communication needs.

a) In theory, all intercity business communication needs are substitutable except those that necessitate "face-to-face" communication atmosphere or those that are transactional in nature or involve crisis decision-making (provided that travel time is allowed). On this basis, about 50% of business communications are potentially substitutable. It is believed by the research team, however, that only 25% is likely to be the upper limit for substitution by communications of intercity business travel by air and rail modes.

b) Personal communications which normally require "face-to-face" atmosphere are believed to be non-substitutable.

c) Non-business type of communication needs, including social services and communication needs of handicapped persons are potentially substitutable.

d) Shopping by businesses and institutions is substitutable. On the other hand, household shopping is partly substitutable.

e) Medical information exchange can be carried out through telecommunications.

f) In the future, the use of remote visual inspections, remote monitoring of instruments, remote manipulation of objects and/or tools may replace some direct person-to-object types of interactions.

2/ Predicting substitution decisions is difficult since such decisions involve the complexities of individuals' value structure, the policy of the organization in respect of communication and travel, tasks associated with the communication needs, the available transportation and communication modes, and external factors.

3/ A large number of transportation activities and operations can be complemented with computer-communication systems. Such opportunities exist in most modal systems except, perhaps, pipeline, which are well served in this respect. Cost-effective applications of computer-communication systems can be made in:

- road traffic (network control, traffic advisory system, freeway metering and surveillance, speed limit enforcement and advice, and congestion pricing),
- user information for short headway type of urban public transit,
- transit fleet control,
- ride sharing in urban areas (i.e., dynamically matching supply and demand in car-pooling and van-pooling), and
- highway freight transportation and distribution management.

Additionally, air transportation, freight railroad, and passenger railway carrier (in ticketing and intermodal aspects) could be made more efficient through the application of information technology.

4/ A large number of factors affect the transportation-telecommunication interrelationship. Major factors analyzed in this study (in terms of their trends) include: transportation attributes; land use and spatial factors; and computer-communication technology, planning, marketing and institutional factors. Communication contexts (i.e.,

urban/regional, inter-city, international (trans-border/North-South, East-West, Northern Canada) are examined and factors that affect substitution of telecommunications for transportation are studied. Similarly, the influence of major factors on the success of substitution type of opportunities are noted.

5/ Information technology-related factors affect the use of telecommunications either as substitutes for travel or as complements to transportation systems. Significant further improvements and/or new developments are expected to materialize in the following aspects of computers and communications technology:

- computer developments in terms of storage capacity, processing speed, mobility, and cost,
- communication capacity, speed, mobility of sender and receiver, trade-offs between capacity, speed and costs,
- the confluence of computer and communications technology,
- developments in office automation in terms of local area networks, teleconferencing, electronic mail, videotex, human factors, voice recognition systems,
- planning, marketing and institutional factors.

The results of these developments are:

- increased transportation information handling capability,
- use of computers and communications to support "real-time decision-making",
- feasibility of on-board systems,
- computing power in small stationary devices (e.g., telephone),
- meaningful trade-offs in the development of optimal systems based on the amount of data stored, processing speed and cost,
- rising human costs may begin to offset declining equipment capital and operational costs,
- increased communication capacity will enhance the "communication shared space" between communicants, thus enhancing the chances of substituting telecommunications for travel,
- increased potential for remote monitoring and remote control,
- mobility of sender and receiver may reduce the need for physical contact.

6/ Areas of substitution are categorized as: teleconferencing, remote work centre (satellite office), remote work centre (home), teleshopping, telemedicine and telecourse. Application contexts are discussed in the report from the perspectives of existing experiences and future outlook, and the extent of travel substitution is estimated. Impacts are likely to occur as a result of travel substitution, including reduction of traffic on transportation infrastructure, petroleum fuel saving, user benefits, improved use of telecommunications infrastructure, environmental quality and net impact on the economy. Also treated in this study are the commercialization time (years) and diffusion time horizon, and relative cost of implementing telecommunication initiatives. For all substitution types of opportunity areas, the direction of impacts is generally uniform, whereas the extent of the impacts differs from one area to another. In general, the transportation industry is expected to lose traffic. The extent of such a loss depends upon the substitution initiative. In the case of teleshopping, public transit ridership loss is expected but at the same time an increase in local goods delivery traffic could result. Finally, an attempt is made to define a likely role for the government in respect of substitution types of initiatives.

7/ From the long list of complementable transportation activities and operations, a number of opportunities appear attractive. Those analysed here include urban and regional road, traffic and driver service improvements, public transit user information services, public transit vehicle/fleet control (location, monitoring and dispatching), real-time ride-sharing information support, highway freight transportation and distribution management, and telecommunications in urban and transportation planning. Within the initiative of urban/regional road traffic or service improvements, six interrelated activities can be assisted or made possible by computer-communication systems. These are area-wide network control, traffic advisory service, freeway ramp metering and surveillance, speed limit enforcement and service, and congestion pricing. Public transit information services are required in such service contexts as bus stops, public transit terminals, homes and to serve the information needs of handicapped persons. Impacts of complementing transportation with telecommunications are categorized and their direct impacts as well as relative magnitudes are estimated in a manner similar to those of substitution initiatives. For these complementarity types of initiatives, transportation infrastructure impacts are measured in the form of capacity gains made possible by computer-communications. There are still other applications which could be appropriately assessed in future research endeavors, including safety through driver training, and information support for regulation of transportation.

8/ Methods for assessing opportunity areas are diverse in terms of their rationale, input data requirements and the significance of their outputs. The present assessment task requires the incorporation of 12 criteria that encompass most if not all concerns of interest groups including those of government. Also, only a limited number of criteria are quantifiable in terms of actual impact levels. Achievement levels of the remaining criteria are definable (subjectively) in relative value terms only. All criteria attainment levels are to be expressed in probabilistic terms. Another requirement of the assessment task is that of differential weighting of criteria. Six evaluation methodologies are defined at the outset. These are: pros and cons method, economic efficiency methods, cost-effectiveness method, goal achievement (or overall effectiveness) methods, expected utility method, and Delphi technique. For application in this research study, the goal achievement methodology is judged to be feasible. Two models based on this methodology are developed and implemented on an illustration basis for developing a ranking of 12 opportunity areas. For further work, however, in addition to a real world application of the goal achievement model(s), the Delphi technique is recommended as well.

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APPENDIX A/ ANNOTATED BIBLIOGRAPHY

Annotated literature included here relates to various facets of this project. The bibliography is arranged into sections according to the topics noted. Within each section, annotations are arranged in alphabetical order by the author, agency or by the title.

Selection of bibliographic items is based on:
- a review of selected Canadian and international literature (including published articles, research reports and working documents) that was carried out for this project;
- relevant literature annotations contained in the Abt Study [17] sponsored by MTC (as marked by an asterix in the following listing); and
- relevant annotations contained in a previous report of the principal author [18].

Considering the diverse nature of information required for this study and also recognizing that standard literature databases are of limited scope for unconventional subjects, no attempt was made in this project to use such sources.

Topics

A1/ Factors Affecting the Use of Telecommunications as a Substitute for or Complement to Transportation

A1.1/ "Substitutable" Communication Needs
A1.2/ "Complementable" Transportation Activities and Operations
A1.3/ Transportation, Land Use and Geographic Factors
A1.4/ Technological, Planning, Marketing and Institutional Factors
  A1.4.1/ Telecommunications Technology
  A1.4.2/ Office Automation and Related Technology
  A1.4.3/ Planning, Marketing, and Institutional Factors

A2/ Areas of Opportunity for the Use of Telecommunications to Substitute for Transportation

A2.1/ Teleconferencing
A2.2/ Office Automation, Electronic Mail, Electronic Funds Transfer
A2.3/ Remote Work Centre — Satellite Office
A2.4/ Remote Work Centre — Home
A2.5/ Experience with Substitutes/Case Studies & Available Teleconference User Survey Results
A2.6/ Teleshopping
A2.7/ Telemedicine
A2.8/ Education (Telecourse)
A2.9/ Impacts of Substituting Telecommunications for Travel

A3/ Areas of Opportunity for the Use of Telecommunications to Complement Transportation

A3.1/ Urban/Regional Road Traffic or Service Improvements
A3.2/ Public Transit Information
A3.3/ Vehicle/Fleet Control — Location, Monitoring and Dispatching
A3.4/ Ride-sharing
A3.5/ Freight Transportation and Distribution Management
A3.6/ Telecommunications in Urban and Transportation Planning

A4/ Techniques for Assessing Opportunity Areas
(Evaluation Techniques)

A1/ FACTORS AFFECTING THE USE OF TELECOMMUNICATIONS AS A SUBSTITUTE FOR OR COMPLEMENT TO TRANSPORTATION

A1.1/ "Substitutable" Communication Needs

Ackoff, R.J., "Towards a Behavioural Theory of Communications", Management Science, Vol.4 (1958) pp.218-233.

In a behavioural theory of communication, Ackoff suggests that the availability of information (i.e., intelligence) has an effect on the decision-making process.

Baker, L.L.H. and J.B. Goddard, "Inter-Sectoral Contact Flows and Office Location in Central London", The London School of Economics and Political Science, Houghton Street, Aldwych, London WC 2A2AE.

A study of office-based activities and the concept of linkage for office location is reported here. The linkages are expressed in terms of information flows via personal contacts. These are studied as a possible criterion for assessing which type of office activity should remain in central locations within cities.

Brayman, H., "Communication in Our Modern Society", Vital Speeches of the Day, 31 (November 1, 1964), pp.50- 53.

The importance and impact of communications in the modern society is outlined in this article.

Communications Studies Group, "Final Report, Volumes 1, 2, and 3", Joint Unit for Planning Research, University College, London (September 1973).

A description of the research undertaken by the Communications Studies Group for the Civil Service Department and the Post Office is provided. Extensive discussion of communication needs is included.

Cyert, R.M. and J.G. March, "A Behavioural Theory of the Firm", Prentice-Hall, Inc. (1965) (332 pages).

The role of the behavioural science as a contributing factor in the establishment of a theory of organizational decision making is described in this book. New concepts are presented on organizational slack, uncertainty avoidance and organizational learning. These concepts are developed for enabling the reader to understand the patterns of decision-making in the organization.

David, Edward E., Jr., and Peter B. Denes (Eds.), "Human Communication: A Unified View", McGraw-Hill Book Company (1972).

This book presents the essentials of a unified view of the communication process. In this process, many different levels are involved and complex transformations from one level to another take place. These transformations are explainable only against the unifying teleological background: semantics. This new viewpoint has come from physiology, anatomy, psychology, linguistics, physics, information theory, and communication engineering. In this volume, papers concentrate on speech communication and use it as an example for presenting a unified view of how semantical, linguistical, physiologial and physical events interact to bring about human communications.

Khan, Ata M., "Travel vs. Telecommunication: Current Understanding", High Speed Ground Transportation Journal, V.10, No.3 (Fall 1976), pp.203-216.

This paper describes the issue of travel vs telecommunication. In addition to other facets of the subject, communication tasks, consumer behaviour and the feasibility of substituting telecommunication for travel are discussed.

Khan, Ata M., "Travel vs. Telecommunications: Modelling Implications", High Speed Ground Transportation, V.10, No.4 (Fall 1976), pp.217-246.

A framework for modelling strategies and associated data acquisition for the investigation of transportation and telecommunication interaction. For the intercity corridor context, models are structured for estimating the propensity to substitute advanced teleconference means for travel. Behavioural characteristics of travel and telecommunication decisions are analysed which from the basic rationale of the research framework and associated models.

Lawrence, H.D., "An Assessment of Travel/Communications Substitutability", Futures, V.5, No.6, (December 1973), pp.559-573.

The article is based on a paper presented at the Rome Special World Conference (September 1973) on Futures Research.

It points out many questions and complications in the consideration of travel/communications substitutability. Also this article presents a very comprehensive overview. The application of economic cost/benefit analysis to the substitution question is examined. The author argues that this form of analysis ignores for too many other relevant issues that should also be studied. These issues include a behavioural analysis of the reasons underlying travel and communications decisions and a consideration of the secondary environmental costs associated with these two activities.

Lawson, F., "Telecommunications and the Customer-Prospects for the 1980's", Long-Range Planning, V.13 (December 1980), pp.70-73.

This article reviews the contribution that telecommunications can make to business efficiency in terms of streamlined telephone usage and the increasing range of new products and services and new networks.

*Philips, D. and Treurniet, W., "Man-machine Interactions in Hermes Experiment: Volume III — Executive Summary", Ottawa: Department of Communications (August 1978).

The author examines various issues relating to teleconferencing and concludes that, for group discussions, meetings, seminars and training seminars, a teleconferencing system can play a significant role in bringing these about more economically and perhaps on a more timely and frequency basis where groups of people are separated by large distances.

*Science Council of Canada, "Communications and Computers: Information and Canadian Society", Ottawa, 1978.

A somewhat uncritical promotion of the information society, which argues that: "In many ways telecommunications will act as a substitute for increasingly expensive physical transportation."

Scientific American, "Communication", A Scientific American Book, W.H. Freeman and Company, San Francisco (1972).

This book contains a number of articles that originally appeared in the September 1972 issue of Scientific American. Among many interesting articles covering the broad field of communication, articles of special interest to this project are: "Communication" (presenting an issue on communication as a key feature of life and modern society) by John R. Pierce, and "Communication and the Community" (the rise of the telephone and television suggests a fuller integration of city life) by Peter C. Goldmark.

Thompson, Gordon B., "Three Characteristics of Communications Revolutions", Paper presented to International Conference on Computer Communications, Washington, D.C. (October 1972).

The author reports three characteristics of communications that have been developed by an analysis of the effects of communication revolutions on the societies in which these occurred. Three characteristics include: the increase in the ease with which stored human experience can be assessed, the increase in the size of the common information space shared by the communicants, and the increase in the ease of discovery and development of nascent consensus. Three tests of significance are also specified which correspond to these three characterizations. These are: must affect the way in which people index information, must increase the range of strategies open to the communicants for the interrupt act, and must increase the probability of transmitting or receiving an interesting but unexpected message. Mr Thompson suggests that such a system of classification will enable developments in the communications field which stand an increased chance of being socially signficant.

Thompson, Gordon B., "The Greening of the Wired City", Communications Studies Group, Bell Northern Research, Ottawa (June 1971).

In this publication, Mr Thompson argues that the horizon of communications systems planners and future users should be widened. A suggestion is made that it is essential to design not only the system but to design for its effects as well. A number of objectives for the wired city are proposed. These deal with the enhancement of values and satisfaction of needs, improvement of economic condition (both in aggregate and in distribution terms), and enhancement of the physical environment).

A1.2/ "Complementable" Transportation Activities and Operations

*Firth, Don, et al., Distribution Management Handbook. Toronto, McGraw Hill-Ryerson (1980).

This book provides a detailed examination of the operational side of Canadian business. The main subject is the broad range of inter-related activities that generally can be described as handling, storage and transportation of goods.

Jeffery, D.J., Ways and Means for Improving Driver Route Guidance, TRRL Laboratory Report 1016, Transportation and Road Research Laboratory, Crowthorne, Berkshire (1981).

This report describes a wide range of possible methods for improving the route guidance information available to drivers, for saving a substantial amount of national resource costs that are wasted by drivers who fail to select optimum routes for unfamiliar journeys. A number of automatic systems are described including automatic electric guidance systems. The electronic guidance system uses buried loops to provide a two-way link between a roadside and a vehicle unit.

Lambert, D. and M. Stewart, "Survey Reveals Computer Uses in Physical Distribution", Canadian Transportation & Distribution Management, (January 1979), pp.35-38.

This article reports on the findings of a recent survey to determine the extent to which the computer is used in the planning and control of distribution and transportation operations by Canadian firms. computer applications to transportation-related and other distribution-related activities are described.

Lambert, D. and M. Stewart, "Survey Reveals Distribution Data Base", Canadian Transportation & Distribution Management, (February 1979), pp. 46-48.

Results of a survey of computer applications in distribution and transportation management are described. A description is provided of the data base reported to be available for distribution decision-making and control of distribution operations. Also, the use of computer simulation as an aid to distribution planning and system design is covered in this article.

RTAC News, "On the Tightrope With Canadian Transit; Will Computers Help Hold Down Spending?" RTAC News, Vol.8, No.3 (May-June, 1982).

At Montreal's Transit Commission, new computerized programs are being introduced to streamline the scheduling and assignment process for bus drivers and subway operators, who number about 4000. The programs take into account a multitude of bus routes, subway lines and garage facilities, along with assignment practices. Still being developed is a computer program that will keep track of the thousands of facts needed for vehicle and equipment maintenance. It is expected that the program will lead to more accurate inventories and projected expenditures for supplies.

Sugrue, Paul K., et al., "Computer Applications in the U.S. Trucking Industry", The Logistics and Transportation Review, V.18, No.2, pp.169-187.

The extent of computer applications in the U.S. trucking industry is investigated by survey sampling. The results of a mail survey are summarized. The authors selected a homogeneous group of respondents and the operating and financial characteristics of computer (electronic data processing) users and non-users in this group are compared. Results imply that the performance of computer users is superior to non-users across a broad spectrum of operating and financial characteristics.

Whelan, Mary S., "Matching Transit Information to the Technology of the '80s", A paper presented at Canadian Urban Transit Association, Toronto (November 17, 1980).

The passenger's difficulty in knowing transit service factors and passenger's need to know are discussed. Also described are the existing transit information packages for O.C. Transpo as well as future developments.

A1.3/ Transportation, Land Use and Geographic Factors

*Abler, Ronald., "Will Telecommunications Replace Transportation?", Telephony, (October 1975), pp.84-94.

A brief analysis by a geographer which leads to a pessimistic conclusion about the immediate prospects for widespread substitution in large U.S. cities.

*Albertson, L.A., "Telecommunications as a Travel Substitute: Some Psychological, Organizational, and Social Aspects", Journal of Communications, (Spring 1977), pp.32-42.

In a very well referenced article, Albertson describes the findings of studies into psychological factors concerning teleconferencing including "cross-modal mismatch" (lack of smell and tactile sensations), and interpersonal influence (persuasion, negotiation). In interviews done with people who work at home, the author discusses advantages and disadvantages of this work environment.

Using the historical example that the first transatlantic cable both increased telecommunications and travel, the author concludes that, "...the availability of teleconference facilities makes long distance communications between groups more feasible, and hence is likely to result in more communication. And this, in turn, will generate a proportion of travel."

Bray, Norman P., Transport and Communications, Waidenfeld & Nicholson, London (1968), 144 pages.

The growth of road, rail, sea, air travel and postal services is illustrated from a historical point of view. The influence and role of these transportation and communications services in shaping the world is discussed.

Cowan, Peter., "Communications", Urban Studies, Vol.6, No.3, (November 1969), pp.436-446.

The major theme of this paper is the future of communications and its effects on society. The impact of communications upon the pattern of urbanization in Britain are studied. The study horizon is year 2000. Major policy issues related to changes in communications are reviewed.

Goldmark, Peter C. and Bonnie, Kraig, "Communications for Survival", Goldmark Communications Corporation, 98 Commerce Road, Stanford, Connecticut 06904 (November 19, 1976).

A special project, called the New Rural Society (NRS) funded by the Federal Government of the U.S.A. is described. This project was designed to examine the application of telecommunications towards upgrading life in rural communities to encourage a voluntary decentralization of people, business and government.

Khan, Ata M., "Land Use and Transport Interaction: Policy and Planning Implications", High Speed Ground Transportation Journal, Vol.8, No.1 (Spring 1974), pp.125-151.

Two interrelated aspects of land use and transport planning are discussed. Firstly, the dynamics of land use and transport interaction are described. Secondly, the policy and planning implications are described.

Lefer, H., "British Airways means business in its pursuit of the business traveller", Air Transport World, (November 1981), pp.59-65.

This article presents some interesting facts regarding the airline industry's reliance on the business traveller for "2/3 of the revenues". The psychology of the business traveller, including "factors" in his "need" to travel are discussed, based upon British Airway's own research. Finally, the article discusses how this airline is trying to retain business travellers by providing better scheduling and extra benefits.

Raphael,D., "Global Economic Environment", Proceedings, Canadian Air Transportation Administration, Aviation Forecasts Conference, Transport Canada (Air), TP3488E, (April 1982), pp.32-37.

This article is one of 13 papers presented at a conference held in Ottawa in April of 1981 on the theme "Aviation in the 80's: Prospects for Growth". The paper identifies three major forces affecting the global business environment of aviation: increasing competition, "turbulence" (as part of which the author created "Turbulence Index", an attempt to measure the depth and duration of economic and social stress and turmoil"), and structural changes leading to increased complexity. Also described are five "worlds": the political world, the economic world, the energy world, "our" world (Canada and the U.S.) and the aviation world.

Using these three forces and five worlds the author discusses the present and future of the aviation business. This paper discusses communications as a threat to transportation describing it as a "sleeper" variable.

"Telecommunications for Metropolitan Areas: Near-Term Needs and Opportunities", National Research Council, Washington, D.C. Assembly Engineering (1977). 88 p.

This study, conducted by the Metropolitan Communications Steering Committee for the Board on Telecommunications-Computer Applications of the National Research Council, identifies telecommunications technologies that could provide useful services for homes, businesses, and governments up to the year 1980. The present state of telecommunication needs and opportunities for metropolitan areas and potential urban applications of telecommunications were examined in light of rapidly evolving technologies and the relative economy of telecommunications. Four major advances in technology were identified as likely to lead in the near future to significant changes in metropolitan telecommunications: increasingly capable terminals, software controlled networks, cellular mobile communications, and fiber-optic cables. Telecommunications applications are considered in such areas as business aids, reference sources, entertainment, government administration, the environment, education, welfare, emergency and mobile services, and citizen safety. Within each of these areas, telecommunications were reviewed in their capacity to improve efficiency and reduce costs, increase timeliness and accessibility of information, and facilitate public access.

"Telecommunications for Metropolitan Areas: Opportunities for the 1980's", National Research council, Washington, D.C. Assembly of Engineering (1978), 117 p.

This report is intended for officials responsible for solving metropolitan problems identifies ways that telecommunications could improve the delivery of public services to metropolitan communities during the 1980's. Areas included in this study are delivery of public services to the home, operation of mobile public services, personal security networks, and energy conservation and management. Major recommendations include the establishment of a pilot program to demonstrate the ways in which telecommunications can help deliver public services to the home and the nationwide implementation of 911 services by legislation if necessary. Because the uses of mobile radio for delivering public services are many and varied, it is deemed unlikely that any single mobile system approach will provide a universally appropriate solution; however, it is recommended that some preliminary experiments with community security telecommunications networks be carried out. Several peripheral but potentially significant applications of telecommunications in energy conservation and management are indicated: substitution for travel, transmitting demand and providing information between consumers and utilities, and facilitating the marketing and transfer of bulk power. A list of references is included.

Transport Canada, Transport Canada's Planning Outlook to the Mid-1980s, Strategic Planning, Ottawa (September 1981). TP3225.

Trends and issues in passenger and freight transportation are discussed. Forecasts of transportation flows are presented.

A1.4/ Technology, Planning and Institutional Developments

A1.4.1/ Telecommunications Technology

Abe Koichi, et al., "Optical Fibre and Cable, Past, Present, Future", Telesis, V.8, No.2 (1981), pp.9-14.

This article describes the history and design considerations behind today's optical fibre and cable. The authors also forecast upcoming developments.

*Appelbaum, H.I., "Trends in Computer Hardware Technology", Canadian Datasystems, (June 1980), p.33.

The author predicts that systems will be faster, less expensive, more reliable, more compact, use less energy and support easier-to-use functionality interfaces. It is also noted that voice input systems are far more expensive than voice-output systems and currently leave much to be desired. Mechanical intermediate storage is likely to become obsolete and will be replaced by charge coupled devices (CCD's) and bubble memories. The latter may replace the floppy disc in use today.

Boyd, J.A., "Communication Cost Containment via Very High Technology", Journal of Telecommunication Networks, V.1, No.2, (Summer 1982).

The perspectives of achieving functional integration through local area networks, wide area networks, and switched networks are discussed.

"CCG's Teletex Service Lets Text Machines Communicate", Canadian Datasystems, (May 1982). p.51.

The Computer Communications Group of the TransCanada Telephone System has introduced a telecommunications service which will allow office text machines such as electronic memory typewriters and word processors from different manufacturers to communicate with each other. This service, called Teletex, is being offered to Canadian users, beginnng in late 1982.

Carne, E. Bryan, "New Dimensions in Telecommunications", IEEE Communications Magazine, (January 1982). pp.17-25.

This author presents a clear description of what is becoming available in the field of telecommunications and what it will be used for. It is stated that combination of new technology and changing needs is hastening the evolution of new communications capabilities exemplified by Videotex, Electronic Mail, Teleconferencing and Interactive CATV. The face of their development depends on the degree of technology push or market pull stimulating their exploitation, the extent to which existing investment may be involved and possible applications in automated offices and wired households.

Chi, C.S., "Advances in Computer Mass Storage Technology", Computer, IEEE, V.5, No.5 (May, 1982), pp.60-74.

This special feature article describes advances in existing techniques, the exploration of perpendicular mode recording, and the evaluation of functional intelligence which are ensuring the continued dominance of magnetic mass storage devices.

Conradi, Jan, et al., "Fibre Optic Technology, Present and Future", Telesis, V.8, No.2 (1981). pp.15-19.

The authors of this article suggest that fibre alone does not make an optical communication system; equally important are the active and passive components — the light sources, detectors, MUX and DEMUX equipment — to which the fibre is connected.

"CNCP Telecommunications", Transmission Facilities and Services, Products and Services, 54-01-07, Auerbach Publishers Inc. (1980).

This portfolio presents an overview of CNCP Telecommunication's present service offerings and its plans for future network expansion. CNCP Telecommunications offers both private transmission facilities and public message telex and telegraph services. This national common carrier group has become a strong competitive force in the Canadian telecommunications industry by specializing in data transmission facilities while developing more innovative services than some of its Canadian and U.S. counterparts.

"Data Communications in Canada", Transmission Facilities and Services, 54-01-03, Auerbach Publishers Inc., (1976).

An examination of the data communications scene in Canada is presented in this portfolio, and some recent developments are described in detail. It also outlines the structure of the data communications industry and its regulatory framework.

Dubois, Eric and Shaker Sabri, "Video Teleconferencing Squeezing the Signal Pays Off", Telesis (1982 one). p.14-18.

A BNR/INRS-Telecom team is developing techniques to compress video information so that less bandwidth is required for transmission.

Ferguson, Michael et al., "IVC: Computer-Mediated Meeting-At-A-Distance", Telesis, (1982 one). p.8-13.

Recent advances in telecommunications, computer technology, and video techniques come together in a complex of services known as Interactive Visual Communication (IVC). The approach taken by this BNR/INRS-Telecom team promises effective multi-site meetings-at-a-distance and creates communication tools not available for face-to-face encounters.

*Fistell, L., "Changing Disc Technology: More for Less". Canadian Datasystems, (March 12, 1980). pp.50-51.

Suppliers report that increased density, lower cost and greater reliability are the key trends in disc technology.

"Five Powerful New Satellites Take Telesat Canada Into The Next Decade", Communication Systems (February/March, 1982). pp.24-25.

Management at Telesat, the national space communications carrier is confident that five new satellites set to go into orbit by 1985 will maintain technological leadership but there are worries about Canada's regulatory and legislative stance.

George, D.A., "Electronic Communications Promise Dynamic Growth", V.64, No.5, (Fall/Winter 1981). pp.10-14.

This report identifies the direct relationship between developments in electronic technology and developments in telecommunications by describing a brief history of the two. Also shown is the possibility of future development of electronic communications following exponential growth curves. The present situation combines communication, control and digital processing systems into "modern information processing systems". With this interrelationship established, an outlook to future developments is made and a heavy emphasis is placed on the role of the electrical engineer or computer specialist in the coming of the new technology.

Gibson, J., "Morse to Magic", Enterpriser, V.5, No.6, (June 1982). pp.23-24.

This article deals specifically with CNCP Telecommunications and their provision of services and "state-of-the-art" technology to Canadian business and manufacturers. The introduction of Infotex, "...a move towards the integrated electronic office", providing a communication link via word processors is briefly discussed. Since its introduction in March of 1982, Infotex "now makes it possible for the same word processors to receive and transmit information instantaneously to and from other word processors and the 50 000 Telex terminals across Canada."

Also discussed is the involvement of other Canadian companies in development of Infotex-compatible equipment including Micom and Nelma Data. There are also brief discussions concerning satellite communications and laser telecommunications systems. A specific example is given. "In May (1982) CNCP and Broadcast Holdings of Montreal inaugurated a national teleconferencing service with a teleconference which linked two thousand doctors at 16 locations in hospitals and universities across Canada..."

Gupta, Viswa, et al., "Talking With Computers", Telesis, (1982 one). p.4-7.

A joint Bell Northern Research (BNR)/L'Institute National de la Recherche Scientifique (INRS) Telecommunication research group is attacking problems in speech processing and man/machine communication.

Holbrook, O.W., "Highly Developed Telecommunications Systems Can Replace Business Travel", Engineering Journal, V.62, (April 1979). pp.8-12.

This article discusses telecommunications technology. Also two interesting observations are made: (1) a jet liner averages about 80 passenger miles per gallon of fuel which is the equivalent consumption of a medium sized car carrying four people; (2) the University of Quebec uses audio teleconferencing on a daily basis to conduct affairs...over seven campuses.

Hughes, G., "Barbados Buys Bell Technology", The Citizen, Ottawa (July 23, 1982).

Northern Telecom International Ltd., has signed an agreement with the Barbados Telephone Company to build a 23.8 km fibre-optic network on the island. The system, which will be able to carry thousands of phone conversations simultaneously, is worth more than $1.5M and includes transmission equipment. Installation of the network, to be manufactured at Northern Telecom's Saskatoon plant, will begin later this year.

Inns, G.E., "Taming the Tiger", Engineering Journal, V.64, No.5, (Fall/Winter 1981). pp.5-9.

This is the first of seven articles in a special issue of the Engineering Journal in which Canadian electronic communications technology is highlighted. The article presents a concise history outlining telecommunications developments in response to customer demands. The latter part of the article recognizes the need for the expansion, flexibility and standardization of transmission networks.

Javed, Alavddin, et al., "Fibre Optic Transmission Systems, The Rationale and Application", Telesis, Vol.8, No.2 (1981). p.2-8.

"Optical fibre is now a viable alternative to copper in a number of telecommunications applications. In this article, the authors show how fibre can be used to reduce transmission, maintenance, and administration costs."

Johansen, Robert, Jacques Valee and Kathleen Spangler, Electronic Meetings: Technical Alternatives and Social Choices, Addison-Wesley Publishing Company (1979).

This book focuses on decision making in illustrated and complex managerial tasks, and on the use of technology to improve decision-making performance. This publication examines an aspect of decision-making omitted in most discussions of computer use — making meetings more effective. The authors deal mainly with the uses of telecommunications in complex and relatively unstructured context of group problem solving and cooperative information exchange among peers. It provides a clear and comprehensive introduction to the technologies of communication, and emphasizes the context and criteria for effective use.

*Napier, James V., "The Future of Telecommunications" in Telecommunications: Trends and Directions, A Seminar Sponsored by the Communications Division, Electronic Industries Association (May 27-29, 1980).

The same advances in micro-processor technology that brought us the digital switch in communications networks are also applicable in

terminal equipment. That means that telephones and PBX's and other terminal gear can take full advantage of the most sophisticated switching equipment. Combined with the improvement in high speed printing, xerography and graphic display systems, the telephone will handle much more than voice calls. The telephone will provide voice store-and-foreward capability with facsimile data and message communications systems. In five or six years, a central processor will automatically switch video, voice, data and electronic mail to the most economical transmission facility available to the user.

Pollock, Harvey, "The Wired City Is Well On Its Way", Computer Data, p.93.

This article suggests that the growth of data communications in the 1980s will completely overshadow that of the previous two decades. Videotex, telecommuting, the electronic office and the mixing of voice and data on a single telephone line are some of the main areas where phenomenal growth will take place.

Pulford, J., "Alberta Introduces Automatic Mobile Telephone System", Engineering Journal, V.64, No.5, (Fall/Winter), pp.52-53.

The article discusses the approach that is being taken to provide an automatic mobile telephone system to an area of 1200 by 600 miles in the province of Alberta.

At the time of the writing of the article, a field trial was being employed in the Edmonton area. The Aurora System will be used to complement the present existing manual operator system. The features of this system are listed including diagrams of how it works and how it will be used.

Reed, William E., "Satellite Television Transmission (citations from the Engineering Index Data Base", National Technical Information Service, Springfield, VA. (March 1980). 152 p. PB0-806318.

This bibliography cites research concerning various aspects of satellite television systems. Topics include broadcasting, television transmission, educational television, frequency allocations, equipment, and applications. (Contains 145 abstracts).

*Salna, J., "What's Ahead for Optical Computing Systems?", Canadian Datasystems, 11 (October 1979) 38-42.

The author states that the use of optical systems components offer the advantages of low cost and high service reliability. He predicts that on-line optical storage systems capable of matching disc/drum magnetic storage are likely to appear in the next three to five years.

Schweiger, G., and Middel, H., "The Application of Optical Fibres in the Local and Rural Networks", Telecommunication Journal, V.49 (February 1982). pp.92-100.

Optical fibre local and rural network is described by comparing it with the existing copper network. The article also derives the requirements for the cables and accessories to be used in this new

network. A possible strategy for the introduction of this technology is outlined. Possible new services are described and the problems of maintenance are discussed. Brief descriptions of current field trials being conducted in Canada, France, Germany and Japan are included in an attempt to prove the technical feasibility of such systems. This article is one of six included in a special "optical fibres" section of this periodical.

*Sharp, D.E., "Data Entry: A Technology in Transition", Canadian Datasystems, Vol.12, (August 1980) pp.40-42.

The author discusses the progression of data entry technology from keypunching through keyboard entry to optical character recognition (OCR) and voice recognition. He foresees continued growth in key-to-disc systems. The introduction of OCR in the early 60s was expected to replace all existing techniques. However, its acceptance was hindered by its technological complexity; user resistance and innovations in competing methods. Voice recognition data entry is a more recent and less-widely used method. Growth is predicted in the number of systems and applications of this technology.

Sweetman, Kari, "The Changing Face of Videotex, Vista Marries Telidon", Telesis, V.7, No.1 (1980).

This article describes Bell Canada's Videotex project called Vista. Also a brief review of videotex development around the world is provided.

"Telesat to Make 14/12 GHz Splash", Canadian Electronics Engineering, (December 1981). p.18.

Telesat Canada, Canada's commercial satellite communications carrier plans new and expanding markets for its services with the launch of third and fourth generation spacecraft. Telesat Canada now has three Anik A and one Anik B satellites in geosynchronous orbits. Between the summer of 1982 and the end of 1985, it will send three, powerful new C and two D servies spacecraft aloft to replace and extend existing 6/4 GHz capacity and, it hopes to enter 14/12 GHz business and broadcasting market in a big way. The five new satellites will cover the country's space communications needs until the end of the decade.

"TransCanada Telephone System", Transmission Facilities and Services, Products and Services, 54-01-08, Auerbach Publishers Inc.

This portfolio presents an overview of the services of TCTS and of its communications arm, the Computer Communications Group. The Trans-Canada Telephone-System (TCTS), composed of 10 of the largest telecommunications companies in Canada, coordinates nationwide voice and data communications facilities on a carrier-by-carrier basis.

A1.4.2 Office Automation and Related Technology

Dawes, Nick, "Electronic Mail Blossoms At Bell-Northern Research", Telesis, Vol.8, No.3 (1981). pp.2-7.

"An internal electronic mail system designed at Bell-Northern Research in changing communications patterns within the corporation. In two years the system has grown from supporting 15 users to over 1000."

Doddington, G.R. and T.B. Schalk, "Speech Recognition: Turning Theory to Practice", IEEE Spectrum, V.18, No.9, September 1981, pp.26-32.

This article evaluates developments in speech recognition equipment. It describes the impact of new integrated circuits and the requisite computer power made possible by the new ICS on speech technology. It offers predictions about the development of speech recognition machines.

Godfrey, David and Ernest Chang (Editors), The Telidon Books, Press Porcepic Ltd. (Toronto), (1981).

The editors discuss in the introductory section the Telidon development both as a technology and a social phenomenon. Articles on these aspects are contributed by various authors knowledgeable about the subject. In broad classification terms, these include marketing, hardware and software, implementing the terminal and buying hardware and software.

*Lusa, J.M., "Time to Put it Together", Infosystems (January 26, 1979). p.36-40.

The author states that the old ways of handling information are becoming displaced by rapidly advancing technology in the form of distributed processing, electronic mail, data-base management, networking and other ideas. The costs of executing an instruction or storing a piece of information will continue to decline. Improvements in magnetic storage devices is reducing the costs of storing large amounts of data on-line. The author also suggests that there will be an explosive growth in the use of display terminals in such applications as automated factories and offices, electronic mail and typesetting services.

Madden, J.C., "Has Telidon Arrived?", Engineering Journal, V.64, No.5 (Fall/Winter 1981), pp.15-19.

This article discusses the viability of Telidon terminals as a replacement for computer CRT terminals. With the advantage of offering colour and graphics, the need for such a system is discussed in a business use and a consumer use. A specific example of a commercial Telidon system, the Grassroots service offered to farmers in Manitoba, is described along with a target market. Some emphasis is placed on the need for most of the competing interests to reach acceptable compromise positions in the development of compatible equipment for the Telidon system.

Metcalfe, R.M., "A Strategic Overview of Local Computer Networks", Proceedings of the Conference on Local Networks and Distributed Office Systems, Online Publications Ltd., London (1981), pp.1-9.

This article provides an overview of local computer networks which is intended to serve as a background against which a number of key

questions may be considered. These questions relate to local computer networking system; unification of voice, video, terminal, workstation, and mainframe local communication during the 1980s; the nature of local networks (i.e., analog or digital, centralized or distributed, etc.); and building of multi-vendor configurations by office system users.

Morton, Auton S. and Martin L. Ernst, "The Social Impacts of Electronic Funds Transfer", IEEE Transactions on Communications, (October 1975). p.1148-1155.

This paper reports on selected elements of a technology assessment, carried out by Arthur D. Little, Inc., for the National Science Foundation, of electronics funds transfer (EFT). Following a brief placement of EFT into historical perspective, the paper describes what EFT is and what it does. Some EFT experiments and their results are discussed. Also described are means by which EFT may be introduced and some impacts identified on the financial industry, privacy, loans and credits, security, and the family.

Parkhill, D.F., "Electronic 'Office of the Future' Becoming Present-day Reality", Engineering Journal, V.64, No.5, (Fall/Winter 1981), pp.20-22.

This article outlines the Canadian government's involvement in encouraging research and development in microelectronics technology by Canadian industry. The Department of Communcations, through its Office Communications Systems Program started in 1979, is conducting activities in two phases. Phase one involves, contracts to Canadian industry to develop specifications for an integrated office of the future system; contracts to undertake behavioural studies on information flow and employee reactions to the new technologies; and limited field trials of prototype office systems in government departments. Phase Two is planned to include limited production runs by Canadian industry, full-scale field trials and the refining of products for market.

Peterson, John, "What To Know About Local Area Networks", Canadian Data Systems, (May 1981), pp.50-51.

A description is provided about local area networks and how they link mainframes, minis, terminals, telephones, text editing and facsimile devices within a building or plant complex.

Uhlig, Ronald P., David J. Farber and James H. Bair, The Office of the Future, Communication and Computers, North-Holland Publishing Company, New York (1979).

This book consists of three parts. Part I describes uses of computers in the office of the future. Part II covers the technological imperatives. Part III discusses the issues of the impacts of office automation.

Walter, A., "World"s Your Oyster", Enterpriser, Vol.5, No.6, pp.27-30, June 1982.

This article concerns CCG, The Computer Communications Group of the TransCanada Telephone System and their contribution to the "office of the future-today" with iNET and Teletex. An emphasis is placed on iNET's "single point to access to satisfy all business information needs". The article also discusses CCG's Teletex service, another system allowing appropriate word processors to communicate nationally and internationally via TCTS's public switched telephone network. The involvement of Canadian manufacturers is stressed along with the need for standards so as to have compatibility among the equipment.

A1.4.3/ Planning, Marketing and Institutional Factors

Alexander, Tom, "The Postal Service Would Like to Be the Electronic Mailman, Too", Fortune (June 18, 1979).

This article discribes the issue of electronic mail in terms of threats to Postal Service monopoly. The U.S. Postal Service has been forced into a complex battle with big business and Washington regulators for its desire to enter the modern era of electronic mail.

Anderson, William S., "Barriers to Progress in Telecommunications", Computer Networks, V.5 (May 1981). pp.325-330.

The focus of this article is on issues and challenges in the telecommunications industry. Foremost among these challenges is the further integration of computer and communications technologies. A number of remedial steps are suggested by the author.

Baldwin, Susan L. and Gilles P. Rouleau, "Viewpoint, Office Automation: From Barriers to Gateways", Telecommunications Policy, (December 1981). pp.323-325.

The authors examine the barriers to office automation which may be responsible for the reluctance of many executives to proceed with automating the office. Additionally, they offer suggestions for removing the real and perceived obstacles to office automation.

Bartlett, Frederick M., "Streamlining the process only way to achieve reform", CIPS Review, V.6, Issue 3 (May/June 1982).

This article suggests that legislative initiatives aimed at reflecting the true state of telecommunications in Canada are urgently needed as a first step toward regulatory reform. Adding to the legislative dilemma is the sad reality that there is an acute policy vacuum. One remedial measure is to clearly differentiate between policy formulation and regulatory reponsibilities. Also, reducing the extent of regulation is a must. It will help to cut the "regulatory lag" that handcuffs Canadian firms.

Campbell, J.A. and Thomas, H.B., "The videotex marketplace, a theory of evolution", Telecommunications Policy, V.5, No.2 (June 1981), pp.111-120.

The authors present their views on the factors that will influence the use of videotex in business; how it may evolve as a business tool; and how its early impact in the business environment may eventually be the cause of its acceptance as a mass consumer medium.

Charles, Jeff, "Approaches to Teleconferencing Justification, Towards a General Model", Telecommunications Policy, (December 1981). p.296-303.

Five major justification perspectives are combined to form a general model that charts their likely impacts on productivity of organizations considering teleconference systems. These are intuitive leap, cost effiency, timeliness of decisions, improved work coordination, and reaching out. The author logically advocates proper planning through teleconferencing feasibility studies.

Colville, David, "National dimension to policy will help achieve goals", CIPS Review, V.6, Issue 3 (May/June 1982).

This article suggests that telecommunications policy in Canada has been plagued by jurisdictional squabbles. If governments consult and cooperate, Canadians will have the best possible service. The author notes, however, that "national" does not necessarily imply federal jurisdiction. National, in the Canadian context, can and does mean (in many areas) a cooperative arrangement between the federal and provincial governments.

Connell, J.J., "The People Factor in the Office of the Future", Administrative Management 41 (January 1980): 36-37, 74-76.

The author cites two factors which are likely to hinder the acceptance of the "office of the future" technologies. Firstly, the organizations are not capable of doing the planning necessary to use the technology and secondly people may resist the technology thereby creating a hostile environment.

Dryden, A., "Cable Exciting... But", Enterpriser, V.5, No.6, (June 1982), pp.25-26.

According to the author, the trouble with cable-TV is that it still isn't properly defined — as an integral component of the nation's broadcasting system or as a common carrier, or both. Consequently, it has proven, apparently, very difficult for the Department of Communications or the regulatory agency, the Canadian Radio-Television and Telecommunications Commission, to decide and lay down permanent policies which would enable industry to plan with confidence its investments over the next decade.

Flaherty, David H., "Canadian Launches study of international privacy laws", CIPS Review, V.6, Issue 3 (May/June 1982).

This article describes an international study of the laws that protect (or don't protect) private data. The study will include many issues and questions intrinsic to the development of data protection in comparative perspective. This includes an analysis of the recent introduction of data protection laws and legislative process to date; the characteristics of public policy-making in this area; litigation under data protection laws; and administrative problems that have developed in enforcing them. A central part of the study is thus the comparative analysis of existing and proposed data protection laws in several countries.

Gassmann, H.P., "OECD Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data".

On September 23rd, 1980, the OECD Council approved these guidelines. Australia, Canada, Ireland and United Kingdom governments have abstained at that time. These guidelines apply to all types of data processing, whether manual or automated.

Hall, D.C., "Electronic Communications — a pragmatic evolution", Engineering Journal, V.64, No.5, (Fall/Winter 1981), pp.43-47).

The author suggests that the electronic communications industry is leaving a period in which it has been technology-driven to move into an era in which it will be market-driven. Technology will not act as an inhibitor to the development of electronic communications. However, some obstacles will be encountered: a need for a means of encryption to provide privacy, the basic unwillingness of people to deal with change, initial costs to a purchaser and legislation. The article recognizes these problems and briefly mentions some solutions. Finally, it is stated that the "information services network will become a reality because the forces demanding it are gaining momentum constantly at the expense of the inhibitors.

Johansen, Robert, Kathleen J. Hansell and David Green, "Growth in Teleconferencing, Looking Beyond the Rhetoric of Readiness", Telecommunications Policy (December 1981), p.289-295.

This article addresses the reasons why teleconferencing has not yet been implemented on a large scale. An outline of readiness factors and enabling forces relevant to teleconferencing growth is provided. The authors argue that the optimistic demand forecasts made in the past were based on the assumption that the readiness factors would rapidly evolve into enabling forces. The authors believe that enabling forces are only beginning to emerge.

Kobayashi, Kogi, "Computer, Communications and Man: The Integration of Computer and Communications With Man as an Axis".

This article trades and projects the development computer and communications technology and explicitly incorporates the human factor. The human factor is called, by the author, either software or intelligence since both relate to the ability of the human being. It is also described that software will play a very important role in the creation of a man and computer and communications society.

Leduc, N.F., "Teletex and Videotex in North America: The Canadian Perspective", Telecommunications Policy, Vol.4, No.1 (March 1980), pp.9-16.

The author presents basic information on the various videotex and teletext trials scheduled and underway in Canada. She identifies the organizations concerned and their interest in this technology and service concept. The underlying issues motivating both government and private enterprise to fund the trials are then discussed.

McCrum, W.A. and Ryan, M.G., "Risks and Benefits of New Communications Services, The National Perspective", Telecommunications Policy, (March 1981), pp.33-39.

New forms of data communications services from a Canadian perspective are discussed and issues associated with services and the new society they encourage are identified. The relationships of new services to national sovereignity, employment, national trade balance, and regulation are discussed from a benefit-risk perspective.

Millar, Alan, "Why You Are Not Using Satellites — Yet", Canadian Electronics Engineering (December 1981). p.26.

With many new North American satellites planned for launch before 1985 there will be enormous innovation at the network usage level. The 1980s are the decade of opportunity for the telecommunications users, and the challenge is with the user if new business services are to be developed.

Science Council of Canada, "Planning Now for an Information Society: Tomorrow Is Too Late", Ottawa (March 1982), 77 pages.

Based on the findings of Science Council's Committee on Computers and Communication: Information and Canadian Society, this report reviews new technologies, the information economy, the human dimension and suggests a national response. The treatment of the subject is broad in terms of viewing Canadian developments in an international context and discussing implications for industries and institutions.

Smith, Morley J., "Government Must Lead Way With Clear Set of Policies", CIPS Reviews, V.6, Issue 3 (May/June 1982).

This article suggests that there is a lack of consistency between various telecommunications jurisdictions. A new federal Act is recommended, as a guideline for business and other levels of government.

Sutherland, J.G., "Competition enhances Canadian telecommunications industry", Engineering Journal, V.64, No.5, (Fall/Winter 1981), pp.48-51.

The article deals exclusively with CNCP Telecommunications organization and its role to create the element of competition in the area of business communications. This includes the development of new market-oriented services, the introduction of state-of-the-art technology, attention to customer needs and quality of service, and pressure to keep costs to customers as low as possible. A discussion of currently available CNCP systems is presented including Infodat (a digital network offering dedicated data circuits); Infoswitch; Telepost (an electronic mail service); and Infotex (a worldwide network of communicating word processors). The article ends on a positive note of predicted continued growth for CNCP including a project with the Department of Communications to provide a satellite business communications network to some major government departments.

*"Video Discs; A Three-Way Race for a Billion Dollar Jackpot", Business Week, (July 7, 1980).

By the end of 1981, three technologies and at least twice that many giant companies will be pitted against one another to win the lion's share of the U.S. consumer market in video discs. Coupled with a little computer power, they promise to change the way that employees are trained equipment is maintained, students are taught, and products are demonstrated and sold. Experimental projects are being financed in data base management systems, tele-conferencing systems and training simulators. An interactive training movie on karate — the same scene can be viewed from several different vantage points — is being developed. Another company is experimenting with discs in conjunction with voice recognition and touch recognition, because people do not like to use kayboards and because keyboards are error-prone.

Vivian, Peter, "Electronic Mail and the Post Office", Canadian Information Processing Society (CIPS) Review, (October/November 1979).

This article is directed at an analysis of the recent proposals in Bill C-27, the Canadian Post Corporation Act and specifically, the provisions relating to electronic mail.

*Weissman, T., "Another Technology in Search of a Market", Canadian Data Systems, (February 1980), p.25.

The author points out that there has been little discussion of the potential market for the information services made possible by the current video information technology. He feels that it is necessary to determine whether a mass consumer market does exist for these services and if so what type of information and services does the public want and are they willing to pay for these?

Wilkens, H. and Plenge, G., "Teleconference Design, A Technical Approach to Satisfaction", Telecommunications Policy, (September 1981), pp.216-227.

This article reports the findings of a study on teleconferencing. The purpose of the study was to establish a teleconferencing means that would meet the needs of users and be reasonable in cost. Extensive detail is given to data such as, "Groundplan of the conference room", placement of monitors, cameras, loudspeakers, and lighting; document transmission and sound transmission. Overall, it can be said that picture-supported conferences are in every respect as good as, if not better than normal conferences.

A2/ AREAS OF OPPORTUNITY FOR THE USE OF TELECOMMUNICATIONS TO SUBSTITUTE FOR TRANSPORTATION

A2.1/ Teleconferencing

"ARCO $20 Million Talk Network". Business Week (July 1980) pp.81-82.

ARCO plans to institute a video teleconferencing service that will eliminate the need for ARCO executives to make trips for many of their face-to-face meetings. One of the suppliers for this system notes that video conferencing is likely to be cost-effective for at least the top 500 companies in the U.S. However, industry experts suggest that resistance will be high, especially among middle management.

*Bischof, I., Moffatt, P. and Murphy, C., Summary Record of the ANIK-B Users Meeting, Ottawa (June 5, 1980).

The general purpose of this meeting was to exchange information and ideas concerning the ANIK-B communications program, learn of the progress of the individual pilot projects and discuss future plans. As of the meeting date, few of the experiments had been evaluated and none completely.

*Chumak, A., "The Potential for Telecommunications as a Travel Substitute", Role of the Automobile Study, Transport Canada, Working Paper No.10.

This article questions whether telecommunications will be used widely or will be restricted to the technological elite as it is today. The author presents an overview of existing technology and examines such factors as inter-city teleconferencing and the potential for applying telecommunications to work activities. The author examines these in the context of investments required, employer attitudes and psychological factors. He concludes that, given social values and other factors, it is unlikely that greater than 1% of the Canadian labour force will telecommute by the year 2000. Rather, the main impact of the new technology will be on decentralized growth. In terms of teleconferencing, the author proposes that its usage will depend on the importance of cost considerations as well as the nature of the business meeting.

*Collins, H., "Forecasting the Use of Innovative Telecommunications Services", Futures 12 (April 1980), pp.106-112.

This article analyses the demand for teleconferencing using an analysis of present business meetings. The author concludes that audio-only media are as good as audio-visual or face-to-face media for collaborative problem solving meetings between groups of people who know each other. Conversely, face-to-face is generally preferred for meetings involving negotiations or bargaining. Finally, audio-visual is preferred to audio only where it is necessary to get to know people.

Cross, Thomas B., "Computer Teleconferencing — Being There Without Going There", Telecommunications, (May 1982).

Key features and advantages of computer conferencing are discussed. For cost and time saving reasons, the author believes that executives will be turning increasingly to teleconferencing for knowledge and effective communication.

Darwin, E.S., Transportation and Telecommunications, Volume I, The Potential Effects of Telecommunication Innovation on Intercity Passenger Transportation in Canada, Intermodal Passenger Branch, Systems Planning Directorate, Transport Canada, Ottawa, (January 1982).

This volume examines a number of key potential effects that telecommunications innovation could have on intercity passenger transportation. An introduction to forthcoming Volume II is also provided.

*Harkness, R.C., Technology Assessment of Telecommunications/Transportation Interactions: Introduction, Scenario Development, and Policy Analysis, Stanford Research Institute (1977).

This technology assessment identified and analysed the social, economic and environmental consequences of possible future changes in the relationships between telecommunications and transportation. Scenarios were used to describe these changes. The scenarios were found to have significant implications for energy conservation, urban development, commuting, mass transit, job accessibility for persons unable to commute, communications within organizations, residential locational freedom, the telecommunications industry, the airline industry, and other areas.

*Hough, R.W., Teleconferencing Systems: A State-of-the-Art Survey and Preliminary Analysis, Washington, D.C., National Science Foundation Research and Technology (1979).

This study describes the various types of teleconferencing systems that have been set up around the world and performs a preliminary analysis of this area. The author suggests that teleconferencing appears to have a potential of becoming very useful. Audio systems appear to have a potentially bright future because they are economical, cost-effective, can be installed virtually anywhere, and can be constructed to whatever degree of sophistication is desired. Conversely, video and computer-based systems have much higher costs than audio systems and their effectiveness is only marginally greater. The author points out that much research is still needed, in relation to teleconferencing. Unanswered questions include audio/versus video, differences among applications, most useful application, impact on travel, and finally how people will react to teleconferencing on a broad scale.

Hoyle, Ken, "Searching for Substitutes", Telesis, (December 1979).

Forms of modern telecommunication modes are discussed from the perspective of their potential to serve as substitutes for travel. The author states that the present services have been largely determined by technological changes and advances, vth consumers selecting and adapting after the fact to those that were useful and convenient. The services of the future, according to the author, will be developed to serve customers' needs and preferences and adaption of technology to these needs.

*Jull, G.W. et al., Research Report on Teleconferencing Volume 1 — Executive Summary, Communications Research Center, Report No.1281-1, (January 1976).

This report is the result of a three-year study undertaken to assess the potential of teleconferencing as a means to improve the effectiveness of communications within federal government departments. Both audio and video teleconferencing systems were examined. The authors suggest that teleconferencing complements, as well as substitutes, for travel. It can generate unexpected and fruitful new types of communications, as well as substituting for some business trips. In the DOC, the use of teleconferencing created approximately four times more meetings between headquarters and regions than had previously been held on a face-to-face basis. Usage of this means of communications was found to be related to the purpose of the meeting, the distance between participants and the attitudes of users. Audio teleconferencing was found to provide significant economic benefits when used to substitute or complement business trips. On the other hand, video systems cost over ten times as much as audio systems, and on an economic basis were not found to be cost-beneficial. This report concludes that teleconferencing is feasible and can be very useful as an aid to communications between decentralized units. However, all systems examined were found to have major technical limitations which made them unsuitable for federal government use.

*Katsoulis, Michael, Travel/Communications Substitution — Its Potential for Energy Conservation in Canada, Bell Canada (February 1976).

The substitution of telecommunication services for travel is expected to manifest itself initially in inter-city corridors. The realization of the remote work centre and working from the home is not anticipated on any significant scale before the late 1980s, if ever. Inter-city substitution involves less digression from established social norms and behaviour patterns than does intra-city substitution and may, therefore, be more realistically contemplated. Based on current data on energy consumption, combined with Bell's data on the potential for teleconferencing substitution of travel, the author estimates that the proportion of total petroleum energy that might be diverted by substitution would equal 1 to 1.5% of Canada's total consumption.

Khan, Ata M., "Transportation and Telecommunications: A Study of Substitution, Stimulation and Their Implications", Report No.121, Systems Analysis and Research Data Base Branch, Canadian Transport Commission (June 1974).

This study highlights the relationship of transportation and telecommunications in terms of the nature and extent of substitution and stimulation, and outlines the implications arising therefrom. The report consists of the text which integrates and evaluates findings in this area, and the annotated bibliography covering relevant aspects of the subject.

Kollen, James H. and John Garwood, "Travel/Communication Tradeoffs: The Potential for Substitution Among Business Travellers", Bell Canada, H.Q. Business Planning (April 1975).

This Bell Canada study focuses on the substitution of interurban travel and in terms of summarizing previously published findings and statistical analysis as well as the results of a survey of intercity travellers. The Bell survey measured five types of variables tapping such factors as communication situation variables, travel demographic variables, idiosyncratic variables, role variables, and communication alternatives to travel. The analysis was aimed at the question of how well these variables distinguish business travellers who would substitute their current trips with communication alternatives from those who would not do so.

Lorenz, C., "Teleconferencing: new research shows unexpectedly large demand for sound-only systems", Telecommunications Journal, V.44, (November 1977), pp.539-544.

The report provides a European outlook to teleconferencing with specific references to the U.K. and France. Using data from reports by the Communications Study Group (CSG), the European Conference of Posts and Telecommunications (CEPT), and the Stanford Research Institute, the article establishes the viability and potential for sound-only teleconferencing systems in business applications.

Memmot, Frederick M., "The Substitutability of Communications for Transportation", Traffic Engineering 33 (February 1963), pp.20-25.

A useful taxonomy of the inter-relationships between communications and transportation.

Pool, I. de Sola, "The Communications/Transportation Trade-off", Policy Studies Journal (November-December 1980). p.74-83.

This author contends that any simple statement that communications either increase or decrease travel is not only empirically wrong, but conceptually confused. However, the author believes that it would be rational policy to provide improved communication facilities which offer a low-cost alternative to trips that people would rather avoid.

"Video Conferencing: A Cost-Efficient Ingredient in Marketing Mix Today", Marketing News (October 3, 1980), p.12.

While the vast majority of U.S. companies elected to hire outside telecommunications firms to stage their conferences, several large corporations, especially those with high travel expenses, have elected to purchase and operate their own in-house systems. Cost estimates for private video conferencing equipment run up to $150 000.

A2.2/ Office Automation, Electronic Mail, Electronic Funds Transfer

A2.2.1/ Office Automation

*Kleins, J.E., Conceptual Definition of an Automated Office Network for the Federal Government, Report prepared for the Department of Communications, Government Telecommunications Agency, Ottawa (September 1980).

The author states that is clear that a large-scale change is underway in the office, with a potential impact far more disruptive than that experienced in the automation of the industrial sector. This will not be, however, automation as we have known it. A new approach will be needed to cope with the requirements of the office environment of the 1980s.

*Morgan, Howard L., "The Future of the Office of the Future", (paper presented at the Office Automation Conference (March 3-5, 1980), Atlanta, Georgia).

The author's starting point is the assumption that "the much-touted office of the future is finally here". He addresses himself to what comes next. Present-day information and word processing systems, he claims, do a poor job in dealing with the user. So far the attention has been mainly focused on the narrow task of getting information into, processed, and out of systems. What is necessary is far more research into making systems more friendly to the user. Office equipment will also have to be better functionally integrated, and networks will have to be better interconnected. At the moment problems of addressing, standardization, formating, directory structures, and network control are still matters for future research. The interconnections must not only permit computers on one network to exchange messages with those on other networks, but also permit the transmission and translation of information in varying modes (TV, voice and image). We have barely begun to scratch the surface in the use of truly high technology to assist people in offices.

*Poppell, H.L., "The Automated Office Moves In", Datamation 25, (November 1979), 73-77.

The author suggests that office automation technology could pare the cost of white collar operations by more than $300 billion annually by the end of the next decade. This technology will be used in conferencing, information transfer and retrieval, transaction processing and activity management.

*Prince, J.S., "Conferencing System in the 80's", Administrative Management 41, (April 1980), pp.65-66, 70, 74.

This article examines the advantages of teleconferencing over other forms of electronic information exchange. The author concludes that administrative managers will be attracted by the more productive use of time, reduced travel and the ability to participate in meetings in different cities on the same day available through the use of teleconferencing. The advent of satellite communications and the need for rapid dissemination of information in the upcoming decade will make computerized conferencing, teleconferencing and video conferencing an essential part of the automated office.

A2.2.2/ Electronic Mail

*Bruno, Jim N., "Electronic Mail: It Gets There Fast", Administrative Management (September 1979), pp.28-64.

Communication of information via electronic impulse has been with us since Samuel Morse invented the telegraph in the 1840s. Yet, it has taken until now for it to become a business buzz-word. Currently, electronic mail is primarily used for intra-organizational communication between distant points. The new entry in the field of electrically transporting information contained on paper is the communicating copier. Often called "electronic document distribution (EDD), this form of information is especially good for distributing quantities of documents to remote locations. In fact, intelligent copiers as they are sometimes called, are capable of forwarding on time the 10, or even 100, copies of a sales report. Coupled with text editing and data processing equipment, management can now truly get the time savings it has been looking for. The problem with most electronic mail today is the need to have separate equipment to handle each processing requirement — a problem of equipment compatibility. Electronic mail has yet to reach its "threshold" or critical mass. It is at a stage analogous to the early days of telephone networks.

*International Resource Development, Inc., PABX, Interconnect and the Future Office Controller (Announcement, August 1980).

The PABX, once a piece of equipment obtainable only from the local telephone company, is now viewed as being in the mainstream of the trend towards office automation. It can play a central role as the future contoller of information flow within and between offices. The market for PABX equipment is subject to some fundamental limitations, based upn the number of new commercial buildings constructed and the ability of the new equipment to displace older PABX from existing buildings.

*International Resource Development, "Electronic Mail in the 1980's", Norwalk, Conn., IRD, 1979.

Major cable companies in the U.S. are interested in the possibilities of offering security and teleshopping services by two-way cable. Facsimile service into the home is forecast for the late 1980s. Business is revealing new interest in the intelligent telephone and it is possible that the next commercial products will incorporate strip printers. One intriguing, but little-noticed development, is the FAXNET system of Digital Broadcasting Corporation, which is using the FM radio side band for limited mail transmission. Concern for FCC intervention has been expressed.

*Miller, Richard H. and Vallee, Jacques F., "Towards a Formal Representation of EMS", Telecommunications Policy 4, (June 1980), pp.79-95.

The authors understand EMS (electronic message systems) to mean the use of teleprocessing technology and services to facilitate the movement and management of information among people. EMS is an industry that has come of age, since it encompasses telex and TWX as well as telefacsimile, message-switching, computer conferencing,

electronic mail, mailgramme, telegram, communicating word processors and such computer-based services as on-line Delphi systems and some forms off computer-aided instruction. At the moment, the communication capabilitiesy of communicating word processors are limited to relatively low-speed communication with other devices of the same manufacturer. Message switching provides a more sophisticated means of implementing an EMS than the technology previously discussed. These systems require that the users subscribe to a "network" and have on-premises a terminal capable of being "polled" for messages waiting in a buffer. The relay nodes generally don't have enough storage for users "mail" except for short periods of time. Archival storage on a network mode is prohibitively expensive at the moment and the active relay nodes comprising a value-added network rarely have the processing power to allow a fully human engineered system to exist with the network control functions. (For a representative scenario of computer mail use see Raymond Parko, "The Outlook for Computer Mail", Telecommunications Policy 1, (June 1977).

*Vandergeest, C.F.C., "Critical Issues in Electronic Mail" (A paper presented at the 1975 Conference on Telecommunications Policy).

A pilot system between three major Canadian cities can be readily envisaged within present technology. The evolution to a nationwide, universal electronic mail-handling system will, however, be a formidable undertaking which raises economic, jurisdictional, regulatory and technical issues of significant proportions. The post office knows that its new mechanized equipment will reach the end of its economic life around 1990. It follows that the logical time to have an operational electronic mail handling system available would be somewhere between 1985 and 1988. Changes in the makeup of mail that will promote electronic handling area already on the way in the marketplace. Marketing studies have found that about 75% of first class mail is the result of business stimulus. Their experience also shows a shift in origin of mail to the extent that about 45% of all first class mail is estimated to originate in a computer and about 20% is destined to a computer. This means that approximately 65% of our first class mail is already computer-interactive and is either machine generated or eventually machine processed.

*Yankee Group, <u>The Report on Electronic Mail</u>, Cambridge, Mass. (1977-1978).

This report notes that roughly 85% of the recently introduced word processing systems incorporate or can accommodate communications options, however, few users are taking advantage of this. This group feels that word processing has great potential as an electronic mail tool.

*"ACS Faces Formidable Problems", <u>Telecommunications</u>, (October 1979).

ACS, AT & T's new advanced communications service is running into problems providing interfaces which don't require users' software modifications such as access methods and network control programs. There is agreement in the industry that it will take a massive developmental effort to inaugurate even a basic start-up version of ACS in the early 1980s.

*"Attitudes to Electronic Mail", Canadian Office (October 1979).

The tendancy for managers to use their secretaries to convey messages rather than using the systems themselves is going to be a major barrier to the proper use of EMS. Researchers at Mitel laboratories say that training and motivating management personnel are currently the greatest obstacles to using electronic mail systems. The correct use of such systems by managers is essential before companies can reap maximum benefits. Other finds indicate that many companies will have pilot electronic mail systems in operation by the early 1980s; that suppliers have limited understanding of the user problems; and that they will usually try to sell pieces of hardware rather than system benefits. Of concern as well, are problems with software, lack of standards, and lack of compatibility with equipment.

*"Datapoint Leapfrogs Into the Office", Business Week, (December 10, 1979).

With the datapoint system, a single work station can generate a letter, then send it out electronically over telephone lines to printers or terminals in any number of branch offices. By having word-processing in the same memory disc as communications management, the system allows word-processing messages to be cued into the telephone system along with voice messages. The merging of words and data are nearly complete: the next step is to incorporate audio information.

*"Demand for Electronic Mail Exceeds Expectations", Canadian Electronics Engineering, (March 1979).

Telecourier Limited, Montreal, a Canadian marketing licencee for FracScan, the world's first completely automated, public electronic mail system has been reorganized in order to handle an unexpectedly heavy demand for the service. Initial coverage of the system will be between Montreal and Toronto. Vancouver, Calgary and Ottawa will go on-stream shortly afterwards. The common charge for an eight and a half by eleven document will be ninety-eight cents for a two-hour service, terminal to terminal. A fifteen minute express service will cost $1.35 a page and overnight service will be seventy cents a page. All rates are distance-insensitive. The system makes all terminals compatible each with the others.

*"Electronic Information Exchange Findings", Telecommunications Policy, (June 1979), pp.1956-1961.

In 1977-78, four small research communities began using EIES, a computer-mediated communications system. The purpose of the trial was to see if tying together geographically dispersed scientists working in the same research area would increase the communications and productivity within the group. The most notable finding is the low use: about one-third of the scientists either never signed on at all or used it so little that they never progressed through the learning period to the point at which they were exchanging communications with other members of their group. The majority assumed a mainly passive or "read only" role.

*"Is Canada Post On The Way Out?", Canadian Datasystems, (December 1978), p.64.

Refers to the FacScan system and CNCP's telepost service which uses telex to eliminate much of the sorting of mail. It allows any user having a telex terminal to transmit messages of any length to post offices local to the addresses, from where they are delivered by the post office. Users who do not have their own telex terminals can have their messages entered and transmitted at CNCP offices. Micom's system allows an asynchronous communications option for its WP equipment, which permits point-to-point communications between a Micom system and most mainframes, as well as Micom-to-Micom communication. Although most users would generally use the option to send messages within their own companies, a spokesman for Micom said users are showing increasing interest in the potential of electronic mail.

*"New Costpro Device Considered To Be Electronic Mail", Computing Canada, (February 19, 1980).

According to Robert Milne, the co-founder of Costpro, Costpro's goal is a "single electronic window on the world". What Costpro would like to see is a new generation of communications machines determined by trade users needs.

"Portable Electronic Mail, Latest Product in Electronic Message Industry", Electronic Mail and Message Systems, (March 3, 1980).

The latest product is a portable electronic mail terminal from Nixdorf Computer Products in the U.S. Based on their handheld computer, which is currently used for language translation, the terminal would have a modular telephone jack, built in modem and an optional calculator-type thermal-strip printer. It would sell for less than $500 to end users.

*"U.S. P.S. Electronic Mail System", Administrative Management, (September 1979).

An RCA report commissioned by USPS on how electronic mail would be integrated with the mail system, proposed an electronic message system costing between an estimated $1.5 billion and $2 billion. The post office would accept information in written form, on magnetic tapes or electronic signal. Computers would sort and transmit (by satellite if necessary) to other post offices anywhere in the country. The receiving post office would print out the message and deliver it by letter carrier.

A2.2.3/ Electronic Funds Transfer

*Colton, K.W. and Kraemer, K.L., Computers and Banking: Electronic Funds Transfer Systems and Public Policy, New York, Plenum Press, (1980).

This book examines electronic fund transfer system developments in the U.S. and in other parts of the world. The forces that underly the coming changes, the trends in EFT systems technology, and the widespread use of card-activated terminals were briefly discussed and market forecasts were made for these terminals through 1985. Growth

and installations of transaction-oriented terminals will occur as a result of three developments: the merchant expanding his own external retail EPOS system, bank or trusts installing on-line teller terminals and on-premise auto-tellers, and the extension of financial institution terminals into the retail or non-banking environment.

A2.3/ Remote Work Centre — Satellite Office

*Harkness, R., Telecommunications Substitute for Travel: A Preliminary Assessment of their Potential for Reducing Urban Transportation Costs by Altering Office Location Patterns (1973).

The author hypothesizes that advances in telecommunications will substitute for some business trips made between downtown offices and office buildings. An additional resulting factor will be the increase in the percentage of businesses locating outside the central business district.

*Lopez, David A. and Paul Gray, "The Substitution of Communication for Transportation — A Case Study", Management Science, V.23, No.11 (July 1977), pp.1149-1160.

This paper reports on the possibilities of substituting communications for transportation in urban settings. A case study of an insurance company is investigated. An optimization model is developed for determining the number and location of sites to be selected, and the results of the optimization are used as a part of a cost/benefit analysis. The authors conclude that such substitution is economically, operationally, and technically feasible for the firm investigated and that such substitution would be benefit to many firms in the information industries.

A2.3/ Remote Work Centre — Home

*Bedford, Michael T., The Future of Communications Services in the Home, Bell Canada (November 1972).

The main objective of this study was to explore the potential for market development of a number of "wired-city" type communications services (shopping from home, remote banking, information retrieval, etc.). Delphi panelists believed that the large-scale introduction of these services would be preceded by the gradual introduction of education and entertainment-oriented services involving a minimal two-way facility.

Goldman, R.J., "Demand for Telecommunications Services in the Home", Telecommunications Policy, (March 1980), pp.25-30.

The author examines the question of demand for telecommunications services in the home by summarizing findings from research carried out at the University of Southern California. He also discusses trends that are becoming apparent with use of currently available services. He concludes that while there is a home market to be tapped, it needs to be nurtured before any real penetration can take place.

*Gotlieb, C.C., Computers in the Home: What They Can Do For Us — And To Us, Montreal, Institute for Research on Public Policy, Occasional Paper Number 4 (October 1978).

Scientific and technological developments have made computers increasingly indispensable in everyday life in the areas of Government, business, and the home. This study discusses future developments for computers and identifies the effects on our daily life and economic environment should computers become common objects in the home. Tentative applications include electronic shopping, electronic mail, computer augmented instruction, electronic games and household maintenance and operation. It is felt that the wide-spread availability of home computers could result in a considerable re-arrangement between activities carried out at home and at the office. It is concluded that the availability of home computer services will depend on the success in disentangling the numerous communications issues of relevance. The acceptance of the service will depend on their nature, utility, quality, and cost.

*Hough, R.W. & Associates Limited, Pilot Study to Develop a Methodology to Forecast Canadian Demand for New Home and Business Telecommunication Services in the Period 1980-1990, A report prepared for Department of Communications (May 1979).

The report states that what is at issue is not technology, but economic feasibility and market demand as may be seen by the fact that many of the same services have been discussed for as much as 10-15 years prior to 1979 and are still not in wide-spread use. The initial results of the study undertaken in the U.K. shows strong preferences for games, horoscopes and other light entertainment fare as opposed to more substantive information. The authors of this report suggest that there is a need for further information in the form of user attitudes regarding the new services, the observed frequency of use and changes in attitude over time, etc. In regards to the Canadian situation, it is suggested that it may be necessary to take a somewhat more cautious view than reported so far as to the practical rate of penetration in home market, and second, there is no reason at all to assume that videotex is, or will be, exclusively of interest in the residence as opposed to business markets.

9.1/ Experience With Substitutes/Case Studies, Available Teleconference User Survey Results

Cordell, A.J. and J. Stinson, "Travel and Telecommunications: Survey Results To Date and Future Possibilities", A Background Paper Prepared for the Science Council Committee on Computers and Communications, The Science Council, Ottawa (November 29, 1979).

A survey paper was prepared on the subject of travel-telecommunication trade-offs with concentration only on the potential effects of telecommunications on intercity travel for business and government purposes. Topics covered include operational studies, attitude studies, factors impinging on the telecommunication decisions, and factors which indicate increased usage of telecommunications. The authors conclude that travel will still be required for those business meetings which require complex or detailed discussion and between those who have never before met face-to-face.

Gold, E.M., "Attitudes to Intercity Travel Substitution", Telecommunications Policy, (June 1979), pp.88-104.

The first part of this article reports the findings of three surveys conducted on business traveller's attitudes on intercity travel substitution: the (Ronald) Westrum travel survey of 1972; the Business Planning Group (PBG) study at Bell Canada, 1973; and a study based on the BPG's by the Jet Propulsion Laboratory of the California Institute of Technology, 1977. The data and figures collected for these studies are provided in extensive tables. Some interesting conclusions regarding travel substitution are drawn.

The second part of the article deals with the experience of operational teleconferencing systems at such organizations as American Telephone and Telegraph, NASA and Satellite Business Systems. The results would appear to be that "no trend towards intercity travel reduction has been found".

The overall conclusion is that, "to bring about teleconferencing as an effective supplement to or substitute for travel, user organizations will need first and foremost to believe that teleconferencing is a necessary requirement for their organization to grow and survive. This may well occur when their competition uses it effectively."

Holbrook, G.W. and Windler, W.T., "Teleconferencing as a Viable Communications Alternative: An Economic and Statistical Analysis", Technical University of Nova Scotia, DSS-18St 36100-0-9508 (March 1981).

This report is an examination of current teleconferencing systems available in Canada. There is discussion of the shortcomings encountered from both engineering and marketing staff viewpoints with regard to equipment and marketing to the public and private sector.

The appendices contain information collected from provincial and regional telephone companies regarding numbers of hands-free telephone sets now in service, numbers and locations of conference bridges, conference call rate structures and a ranking of telecommunications users.

As part of the report, users reactions to teleconferencing are examined with reasons given for not using teleconferencing. Also included is a User Survey. A trial was conducted of 19 organizations to establish a "factual basis for formulation of methodology to evaluate potential for TC travel trade-off."

Jull, G.W., et al., Research Report on Teleconferencing, Volume 2, CRC Report No.1281-2, Communications Research Centre, Department of Communications, Ottawa (January 1976).

This volume summarizes the results and conclusions of studies which were undertaken during a Department of Communications (DOC) project on teleconferencing. Section 1 presents background justification for investigating teleconferencing as a telecommunications service to

substitute for some business trips. Section 2 reports teleconferencing activities including systems evaluations, technical and behavioural studies, and pre-use attitude studies. Section 3 reports on economicanalysis of teleconferencing. Teleconferencing developments in countries other than Canada are described in Section 4 and conclusions from these studies are provided in Section 5. Finally, a summary of the teleconferencing situation is presented in Section 6.

Leduc, N.F., "The Development of Telecommunications Services: A Review of Projects", Vol. III, "Summaries and Bibliography", A report prepared for Department of Communications (August 1979).

This is the third part of a study to gather information on the trials of telecommunication-based services undertaken in various countries. This part provides a summary of information on the projects reviewed.

The projects reviewed included teleconferencing, computer-mediated communicatons, tele-education, telemedicine and services to the public.

Millard, Gord and Hilary Williamson, "How People React to Computer Conferencing", Telesis, V.44, No.7 (1976).

A Canada-wide, three-month field trial tested on experimental computer system that added a completely new dimension to the normal ways in which people can discuss any common problems. This articles describes some of the system features and users' reactions.

Miller, C.E., "Telecommunication/Transportation Substitution: Some Empirical Findings", Socio-Economic Planning Sciences, V.14, Pergamon Press (1980), p.163-166.

Telephone communication between geographically dispersed members of extended family groups is described from the point of view of subsidized provision of telephone. Data on the communication patterns of sample of New Town families are presented. The study shows that there is no evidence of a substitutive effect. Policy implications of the results are discussed.

Nilles, Jack M., et al., The Telecommunications-Transportation Trade-Off, Toronto, John Wiley and Sons (1976).

A general overview of some of the possibilities for substituting telecommunications for transportation is provided here and the societal implications of widespread adoption of the substitutes are discussed. An interesting case study of telecommunications-transportation trade-off is a specific application to an insurance company is provided. The study draws on survey data to evaluate some of the human factors particularly as they relate to the introduction of word processing and equipment.

Telecommunications Services Branch. Summary Report: Ontario Government Multi-Ministry Hermes (CTS) Satellite Administrative/Operational Experiments, Ministry of Government Services (February 1978).

The report evaluates the program designed to improve services in remote areas of Ontario and concludes that in general the program has been satisfactorily accomplished. In addition, it is felt that the project demonstrated that the energy and resources of various ministries can be harnessed to meet communications objectives. The satellite can be used to provide new alternatives to solving old problems.

Wood, Fred B., V.T. Coates, R.L. Chartrand and R.F. Ericson, "Video Conferencing Via Satellite: Opening Congress to the People",

This teleconferencing project was designed to evaluate (through actual demonstrations) "the effectiveness of satellite videoconferencing as a vehicle for informed dialogue between congressmen and constituents, which can serve to strengthen the legislative process".

In this study, videoconferencing involved two-way interactive television, with TV signals transmitted by satellite. In most of the cases a mobile send-receive earth station was used at the far end, with Washington participants meeting in a send-receive earth station was used at the far end, with Washington participants meeting in a studio equipped for videoconferencing in D.C. In some of the test cases there were more than two distinct points of origin for the teleconferencing, and some cases involved the use of telephone land lines to enable a public phone-in (audio only, of course).

The basic conclusions of the report are that satellite videoconferencing is technically feasible. Participants in the 12 demonstrations found the technology successful in allowing congressmen to reach more people "effectively", in increasing citizen participation and feedback, in saving time and energy of congressmen and constituents and in stimulating citizen interest in, and understanding of, the legislative process.

Comparative costs (transport vs. telecomm.) are discussed.

Wood, Fred B. et al., Videoconferencing Via Satellite: Opening Congress to People, Summary Report, The George Washington University (February 1978).

This report describes a legislative hearing in the form of Video teleconference by the Subcommittee on Science Technology, United States Senate. A Communications Technology Satellite (CTS), namely the public service communications research satellite operated jointly by the United States and Canada, was used. The purpose of this action research was to evaluate (through actual demonstrations) whether satellite videoconferencing can provide a new mechanism for informed dialogue between congressmen and constituents and as a result strengthen the legislative process. The experiment was judged to be successful.

A2.5/ Teleshopping

Martin, James, Viewdata and The Information Society, Prentice-Hall, Inc. (1982).

In Part III of this book, direct selling and mail order is discussed from the perspective of the impact of viewdata technology. It is stated that viewdata could be appropriate for direct selling purposes for items which do not require quality videopictures. An estimated 30% to 70% of items retailed by Sears could be sold through this medium. However, the extent to which viewdata will actually be used for such purposes cannot be established.

Rosenberg, Larry, and Hirschman, Elizabeth C., "Retailing Without Stores", Harvard Business Review, (July-August 1980), pp.103-112.

A2.6/ Telemedicine

*Carey, L.S. et al., "Radiologic Consultation to a Remote Canadian Hospital Using the Hermes System", Journal of the Canadian Association of Radiologists, (March 1979) p.30.

The author notes that this system is extremely reliable and in fact provides high quality audio-visual contact seemingly unaffected by the weather situation. He further notes that, when a network of ground terminals is established for multiple uses, tele-radiology becomes economically feasible.

*Corralt, D.W., "Clinical Evaluation of Four Alternative Tele-medicine Systems", Behavioural Sciences, (December 1977), p.22.

This article concludes that there are no significant differences in the four telecommunication systems used to deliver primary health care to remote populations.

*National Science Foundation, Nursing Home Telemedicine Project, Final Report, Volume 1, (July 1976).

A hospital-based telemedicine system was established at Boston City Hospital to provide higher quality and more accessible medical care to the nursing home patients. The system consisted of a team of specially-trained nurse practitioners supervised by hospital-based physicians, and utilized narrow-band telecommunication technology. The system reduced the number of hospitalizations and days spent in the hospital by study patients. Total costs for medical care were reduced; use of hospital out-patients facilities was reduced; and more sophisticated medical care was practiced in the nursing home.

In addition, medical care was more accessible to nursing home patients, and the program was generally well accepted by patients and nursing home professionals. The narrow band communications were judged to be completely adequate.

*Pomfret, A., Final Evaluation Report on Memorial University of Newfoundland's Tele-medicine Project, (March 1978).

This report concludes that all available data indicate that, as a delivery system, the project can be considered a success by any criteria imaginable, save possibly that of costs.

A2.7/ Education (Telecourse)

*Abrahams, J.R. and Douglas, J.A., "Ontario Schools Embrace Micros But Business Lags Behind", Micros 1 (September 1980), pp.16-19.

This article reviews the successful applications of microcomputers in Ontario education and looks at coming developments in business and industry. In terms of education, the author concludes that the video systems seem to have excellent potential for delivering information and instruction to a widely dispersed population, but the reality is still somewhat in the future. The current systems are very much in a testing and development mode. There is not much evidence yet that microcomputer systems are being used for training in business and industry.

*Dranov, P. et al., Video in the 80's: Emerging Uses for Television in Business, Education, Medicine and Government, White Plains, N.Y., Knowledge Industry Publications, Inc., (1980).

This report looks at new applications, new technology and new uses for the non-broadcast video market. In terms of applications, it is felt that it is unlikely that telemedicine will be used extensively in the near future. A possible growth area however lies in patient education. It is felt that limited budgets and teacher resistance will continue to restrict growth in video at the school level. However, higher education institutions should continue to use video for public relations and recruiting, career training and orientation of both students and faculty. New and growing uses of video in government include the taping of testimony to be presented in court, documentation of evidence in crime and fire investigations and public information/education programming. Training applications include simulations and documentation of events for personnel evaluation.

*Middleton, M.A., Evaluation of the Satellite Tele-Education Project (STEP) in British Columbia, (February 1978).

This experiment involved interaction between teachers and viewers separated by great distances. Viewers at different sites were also able to communicate with each other. The author concluded that the service was not a travel substitute as people would do without the service in absence of the teacher. Rather he concluded it was a complement to travel.

"Telesat Rates Too High For School Programs, Educators Complain", Globe and Mail, (September 23, 1980).

The provincial co-chairman of the federal/provincial task force studying the use of satellites in education said yesterday that governments were prepared to pay a reasonable amount "but Telesat Canada's current prices are exorbitant". The federal government announced at the same time that it will extend financing of the current experimental program until mid-1982, while it and the provinces work out a pricing arrangement for the permanent program.

Weston, Julia, "Telidon: A 'Fantastic Teaching Package' or Not?", University Affairs, (June-July 1982), p.2-3.

This article introduces the technical characteristics of Telidon and assesses its potential as a teaching package. Trial experiences and personal views of a number of educators are stated. In general terms, the article highlights Telidon's creative potential in the educational framework.

A.8/ Impacts of Substituting Telecommunications For Travel

*Chumak, A., "Trends in the Use of Energy in Transportation', Role of the Automobile Study, Working Paper, Transport Canada (1979).

The author notes that the transportation sector in Canada consumes 25% of Canada's total energy requirements. The transportation sector is the largest consumer of oil, accounting for 50% of Canada's oil demand. The automobile is the largest user of oil and oil products followed by trucking.

Friedman, Kenneth M. and Richard M. Oberman, "Transportation and Telecommunications: The Energy Implications", Ann. Rev. Energy (1979). 4:123-45.

In this paper the authors discuss current and projected developments in telecommunications, along with their possible social ramifications. Also discussed are the impact of telecommunications on transportation, and the implications for energy usage and management are explored. Finally, some policy perspectives on telecommunications-transportation interactions are examined.

Feldman, J.M., "Telecommunications: A Threat to Airlines or a New Opportunity?", Air Transport World, (June 1981), pp.18-23.

A concise article concerning the present and future trade-off between air transportation and telecommunications. Some very interesting data are presented concerning Holiday Inns' HI-NET teleconferencing service initiated in June of 1980.

In researching the article, the author conducted interviews with some of the airline world's more important businessmen and has obtained their views towards telecommunications and how it will affect the airline industry. No specific references are given for any of the data.

*Harkness, Richard C., Technology Assessment of Telecommunications/-Transportation, Volume II, Detailed Impact Analysis, Stanford Research Institute, SRI Project 4293, Menlo Park, California (May 1977).

This technology assessment identified and analysed the social, economical, and environmental consequences of possible future changes in the relationships between telecommunications and transportation. Scenarios were used to describe these changes. The scenarios were found to have significant implications for energy conservation, urban development, commuting, mass transit, job accessibility for persons unable to commute, communications within organisations, residential locational freedom, the telecommunications industry, the airline industry, and other areas.

Kraemer, Kenneth L. and John L.King, "Telecommunications/Transportation Substitution and Energy Conservation, Part 2", Telecommunications Policy, (June 1982), pp.87-99.

This paper, which is Part 2 of an article on the subject, examines major factors influencing substitution, including government policy. It concludes that government policy can significantly facilitate telecommunications substitution for travel and, indeed, the achievement of any real measure of substitution may depend upon proactive government policy. The author concludes, however, that this is an unlikely prospect in the current U.S. national policy environment.

Kraemer, Kenneth L., "Telecommunications/Transportation Substitution and Energy Conservation, Part 1", Telecommunications Policy, (March 1982), pp.39-59.

This article is the first of a two-part re-examination of the substitution hypothesis based on research and experience of the past decade. This part examines the theoretical potential of telecommunications-transportation substitution for energy conservation, and reviews recent research both on public attitudes towards substitution of telecommunications for travel and on the operational experience with substitution experiments in organizations.

Kraemer, Kenneth L., Telecommunications-Transportation Substitution and Energy Productivity: A Re-examination, Graduate School of Management and Public Policy Research Organization, University of California, Irvine, California (June 1981).

This report is based primarily on a review and synthesis of existing research and publication on telecommunications-transportation substitution.

McLean, J. Michael, The Impact of the Micro-Electronics Industry On The Structure of the Canadian Economy, Montreal, Institute for Research on Public Policy (1979).

Micro-electronic devices can be expected to revolutionize product repair, medical diagnosis and treatment, education, administration of governmental benefit programs, consulting services, merchandizing and banking. Some services (such as word processing and telecommunications) will suffer particularly severe labour displacement.

*Menzies, H., "Women and the Chip", (Unpublished research project report) Montreal, IRPP (August 20, 1980).

This report examines the diversity between womens' job expectations and skills and the Canadian job market's ability to meet those expectations and employ those skills given the micro-electronic transformation occurring in the workplace and particularly in those centres where women are most concentrated. Over 90% of Canadian office managers both in the public and private sector recognize that improving office productivity is imperative, and have begun to explore and invest in office automation systems and/or technology. No more than 20% of large Canadian firms have launched into full-scale integrated office automation systems. By comparison, it is estimated that 75% of the Fortune Top 500 companies in the U.S. have well advanced office automation systems.

Nilles, Jack M., "Opportunities and Threats From the Personal Computer", Futures II (April 1979) pp.172-176.

A preliminary report of a USC-NSF technology assessment project to be completed by the end of 1980. The report foresees increased employment in personal computers productions and in the service sector, a reduction in unskilled jobs, and a greater opportunity for the education and employment of handicapped persons through the application of personal computer technology.

Oberman, Richard M. et al., "Initiatives for Conserving Transportation Energy Through Telecommunications", The Mitre Corporation (June 1980).

Various telecommunications-related ways of saving transportation energy are discussed in this comprehensive report. A number of candidate iniatiatives were examined and through the use of an evaluation method a list of attractive opportunity areas is prepared.

Pool, I. de Sola, "The Future Role of Telecommunications in the Pacific", Computer Networks, Vol.5, No.3 (May 1981), pp.197-203.

Based on history, the author discusses the impact of telecommunications on the formation of cultural areas, nations and regions. It also discusses the increasing demand for telecommunications using the Pacific Basin region specifically.

*Tyler, Michael, Katsoulis, Michael, and Cook, Angela, "Telecommunications and Energy Policy", Telecommunications Policy, (December 1976), pp.21-32.

An analysis of the energy implications of the substitution of travel by telecommunications, drawing on studies from Canada, the U.K., and the United States. The authors conclude that the influence of the convenience factor is such that it may ultimately prove easier to achieve outright substitution of some kind of trips by telecommunications than to achieve a major shift in the choice of transport mode than for those trips that will cease to be made.

*Westell, Dan, "New Media Impact Held Likely Evolutional", Globe & Mail, (October 29, 1980).

Pay-television is inevitable, but because Canadians already lead the world in viewing choices, demand may be slow. Furthermore, by the time pay-television is widely available, video discs and recorders may be providing a great deal of program variety and quality. Hence, to some degree, Canadian pay-television could be leapfrogged.

Wilkins, Russell, "Microelectronics And Employment in Canadian Public Administration", Canadian Information Processing Society, CIPS Review, V.5, Issue 6 (Winter 1982).

This article describes the effects of microelectronics and computers on municipal employment. Studies conducted in three major Ontario cities suggest that the use of informatics technologies has aided productivity, and at times led to substantial cost reductions for certain operations.

*Zeman, Zavis, The Impacts of Computer/Communication on Employment in Canada: An Overview of Current OECD Debates, Montreal, Institute for Research on Public Policy (1979).

A very useful review of a great deal of recent literature on the micro-electronics revolution, but none of the entries discusses the communication/transportation issue.

A3/ AREAS OF OPPORTUNITY FOR THE USE OF TELECOMMUNICATIONS TO COMPLEMENT TRANSPORTATION

A3.1/ Urban/Regional Road Traffic or Service Improvements

Bogner, Gerhard, "Broadcasts for Motorists", EBU Review, V.XXX (November 1979), p.17-19.

European co-operation between radio stations is described for offering motorists a range of information which is unequalled in scope, speed and reliability anywhere else in the world.

Carvell, Jr., James D. and Donald R. Hatcher, "Dial-in Freeway Traffic Information System", Transportation Research Record 643, Transportation Research Board (1978), pp.37-40.

A telephone dial-in service was developed for providing travel information to the driver prior to a trip. The service was installed as a part of the Dallas Corridor Study, a research and demonostration project concerned with instrumentation, surveillance, and control of urban freeway and arterial facilities. The system was operated for approximately 18 months before it was terminated because of lack of use by the driving public.

Case, Ryerson, E. and Kenneth M. Williams, "QEW Freeway Surveillance and Control System Demonstration Project", Prepared for Presentation to the TRB Annual Meeting, Washington, D.C. (January 1978).

This paper reports the design, operation and results of a freeway surveillance and control system for the QEW Freeway in the Toronto area. The system provides traffic responsive control based on both mainline and ramp conditions, incident detection, hardware status monitoring and a performance evaluation and reporting capability. The system consists of a low light level closed circuit television (CCTV) system, microprocessor-based ramp metering controller, ramp and mainline loop detector installations, a central traffic control computer and a CRT graphic display. A single broadband coaxial cable is used for both television and two-way data transmission.

*Dorsey, Warren, Highway Advisory Radio. Texas Transportation Institute (1968).

An evaluation of an advisory radio project in Texas. A special radio channal existed for highway information. The study found 5-10% of motorists used the system. Extensive advertising increased use to 33%.

Edwards, D.S., Hahn, C.P., and Fleishman, E.A., Evaluation of Laboratory Methods for the Study of Driver Behaviour: The Relation Between Simulator and Street Performance. Silver Springs, Maryland, American Institute for Research (1969).

A comparison of on-road assessment of driving and two simulator assessments of driving. Results indicate low but significant relationship between on-road assessment and accident record. Simulator measures do not correlate with each other or with on-road measures.

Mikami, Tom, et al., "Comprehensive Automobile Control System — A New Urban Traffic Control Trial", NEC Research & Development. No.52 (January 1979).

This paper describes comprehensive automobile control system (CACS) which was designed to include the most advanced function of individual vehicle control systems. A pilot system test was conducted in a part of Tokyo from 1977 to 1978 which consisted of the route guidance subsystem, the driving information subsystem, and the route display board subsystem. These functions are executed and controlled by a hierarchical-structured computer complex including one large-scale computer, five minicomputers, one special-purpose computer and more than 100 specific processors.

*O'Brien, J.F., "Is There a Place for the Simulator in Driver Licencing?" Traffic Safety V.78, #8, (1978).

Compared experienced and novice drivers on an Aetna simulator. Significant differences in performances were found. Unfortunately, novice drivers obtained higher scores than did experienced drivers.

Transportation and Road Research Laboratory, "Report on the Working Group on the Broadcasting of Traffic Information", Crowthorne (England). C1979. 40p. TRRL-SUPPLEMENTARY-506.

A Working Group set up under TRRL Chairmanship has examined the role of improved broadcasting sytems for driver information and considered the case for public experiments. It has been concluded that a comprehensive and well co-ordinated broadcasting system could achieve benefits worth £5 to £10 million each year in present traffic conditions, principally as a result of reduced delays. There could also be a small reduction in accidents and additional, but unquantifiable, benefits from such things as reduced anxiety among drivers and increased efficiency of police control. To achieve these benefits it would be necessary to improve procedures for the collection and processing of information and adopt a dedicated network of transmitters broadcasting an appropriate mixture of local and national traffic information. Trials and demonstrations of improved information collection and handling procedures and of the CARFAX traffic information broadcasting system are recommended.

Schuablegger, John, Brice Stephenson and Stan Teply, "Edmonton Version of Critical Lane Analysis: SINTRAL, An Interactive Computer Program System", ITE Journal, (August 1981), p.20-26.

The program system titled SINTRAL (Signalized Intersection Analysis) is designed to free traffic engineers from tedious computational work and allow them to concentrate on the substantial design features. This program system consists of the following programs: Cycle time, Green intervals, Delay calculation. Another program, Route Coordination, still is under development although its initial version is in use. Still another program, called TRANSYT, originally developed in Great Britain by the Road Research Laboratory (U.K.), has been modified for Edmonton's use. The overall system not only provides a significant general design capability, but also is flexible enough to incorporate local variations of design and analysis parameters.

Wilshire, Roy L., "Cable TV in Your Signal System Future", ITE Journal, (October 1981). p.226-228.

An Increasing number of cities either have installed or are planning to install computer-based traffic signal systems. This article suggests that sharing coax (coaxial) cable of a cable TV system within an urban area is a viable alternative to installing an extensive city-owned communications system for traffic control. Specifying the traffic control needs within the initial cable TV franchise is an effective way to protect this option and develop a favourable working relationship and fee structure.

A3.2/ Public Transit Information

Bonsall, John A., "Better Information Equals More Riders", Paper Presented at C.U.T.A. Conference, Quebec City (22 June 1981).

This paper describes the recent steps that have been taken to improve OC Transpo's information services and some of the preliminary results of ridership increases believed to be generated by the programme. Computer-communication technology applications are described as well.

*Brown, G.R., "Analysis of User Preferences for System Characteristics to Cause a Modal Shift", Highway Research Record #417 (1972) pp.25-36.

Analyses the needs of transit users, showing the distance from a transit stop and delays awaiting the vehicle are the primary constraints on use of transit.

Chaput, H., "New Service Information System", Internal Memorandum and a Working Paper, OC Transpo, Ottawa (Nov. 1979).

A new service information system for OC Transpo (Ottawa) is described and cost estimates are reported.

IBI-JKA, "Easy Rider, The Mississauga Transit Demonstration of the Automatic Bus Passenger Information Concept", Prepared for Transport Canada, Urban Transportation Research Branch (March 1979).

This final report on the Easy Rider demonstration project in Mississauga describes project objectives, description of service, system description, stages, routes, prediction accuracy, waiting times, user characteristics, attitutdes of transit riders to Easy Rider, cost-effectiveness of the system, future prospects, organizational aspects, automatic information, management considerations and the role of governments.

Kates, Josef, "Automatic Information for Transit Riders", Paper Presented at the Mass Transit Show and Conference, Bus Session, Washington, D.C. (February 8, 1980).

This paper examines the role of Telephone Transit Information Services. It suggests that this role be greatly expanded to fundamentally change the nature and impact of transit riding by sharply reducing waiting and uncertainty at transit stops which are the greatest

deterrents to the use of transit systems. The paper describes briefly a very successful automatic bus information system "Easy Rider" in Mississauga.

Peat Marwick and Partners, Surface Vehicle Monitoring and Control Study, An Improved Communications and Information System, Prepared for Toronto Transit Commission (March 1974).

Means for improving the monitoring and control of surface vehicle operations are examined. The preferred system was stated to provide surface vehicles and control centres with two-way voice and data communications, continuous information on vehicle locations and loading, emergency identification, continuous passenger counts, visual display for route supervision, visual display for passenger information, and possible interface with traffic signal systems.

Pickett, M. W., "Trials of Computer-Generated Public Transit Travel Information in Wiltshire", TRRL Laboratory Report 1036, Transportation and Road Research Laboratory, Crowthorne, Berkshire (1982).

Software has been produced by the TRRL to generate multimodal travel information. The output produced by the computer programs underwent a ten-month trial in travel enquiry bureaux and libraries of three towns in Wiltshire from which the information on travel was disseminated to a number of destinations in and around the country. Despite publicity during the trails, the public showed little interest in the guide. Possible reasons for this are examined in the report together with possible improvements that could have been incorporated to increase its acceptability.

Verdonck, Ir. W., "The DOVER Experiment, An Automated Information System for Public Transport Terminals", Transportation Research Board Annual Meeting, Washington, D.C. (January 1982).

This paper describes a feasibility study for an automated information system carried out in the Netherlands for travellers, drivers and management in a public transport terminal. DOVER is an acronym in Dutch for "up to the minute" information for passengers and public transport (drivers and management).

A vehicle detection and identification system collects data about the bus movements in the terminal area and sends the data to a computer in the control centre. The computer processes the data, allots the buses to the platforms and informs travellers, drivers and control centre staff of depature times and platforms of the buses.

Whelan, Mary S., "Good Information Translates into Fuel Conservation", Presented to Canadian Transportation Research Forum Meeting (May 26-28, 1982).

The Ottawa-Carleton Transit Commission (OC Transpo) has embarked on a new comprehensive programme for the provision of transit information. The components of the information package were designed to provide as complete information as possible to the transit user in order to minimize his uncertainty about the system and his inconvenience in using it. As a part of the information system, the "560" Automated Schedule Information is described.

A3.3/ Vehicle/Fleet Control — Location, Monitoring, and Dispatching

*Aaron, Raymond L., "Computer, Hail Me A Cab", Management Controls, (July-August 1977), pp.38-40.

The taxi industry, which was quick to adapt voice telephone and voice radio techniques, is lagging in the use of computers to control and dispatch taxi fleets.

Braun, William V. and Donald L. Walker, "Vehicular Location and Information Systems", IEE Transactions on Vehicular Technology, V.VT-19, No.1 (February 1970).

New tools which offer significant improvements in the efficiency in the management and operation of mobile vehicular fleets are discussed. The various types of location and information reporting techniques which can be used to supplement existing voice-radio communications to achieve the efficiency goal are described. Both fixed and random-route location systems are described.

Centre for Metropolitan Planning and Research, Cost-Effectiveness Evaluation of Potential Municipal Service Application of Cable Television for Baltimore City, (1974).

The study examines potential applications of cable to operations of the Baltimore City Fire Department. These applications are primarily:
1) fire alarm communications;
2) reception-dispatching including ambulance dispatching; and
3) training.
The present volume of communications for the first two operations is substantial and major benefits would accrue from any increases in reliability, decreases in false alarms, and speed-ups in service that could be realized from cable. In the area of training, benefits result primarily from increased uniformity of training available to firemen and from real cost savings. The study concluded that the benefits to be gained from applications of cable to alarm and dispatching systems were marginal and indirect at best, and that major cost-effective applications were to be found primarily in the area of training.

*Clayton, E. Niles, "An Overview of the Land Mobile Industry", in Telecommunications: Trends and Directions. Report of a Seminar Program Sponsored by the Communications Division, Electronic Industries Association (May 27-29, 1980).

The total land mobile radio market is expected to more than double (to $4.7 billion) in the U.S. by 1985. Semi-conductor technology will have the effect of creating smaller, lighter, more efficient and less costly two-way and one-way communications devices. The allocation of 800 MHz frequencies will enable the industry to serve the pent-up demand for mobile radio services through the end of this century. New techniques for expanding the capacity of the tone and message paging channels, including the digitizing of the voice message to minimize use of channel time with conversion back to voice in the paging

receiver, or sending a digized message which could be printed out electronically on the face of the receiver, are all developments designed to provide quicker and better service. New channels will be used in sophisticated systems (known as cellular systems) will greatly increase the capacity per channel and provide quality of service that is comparable to home and office telephone service. The mobile radio industry sees cellular car telephone service as a major opportunity for accelerated growth in the long term.

*"Digital Techniques Speed Police Communications". Canadian Electronics Engineering (August 1976), pp.34-35.

Vancouver's recently opened Police Communications Centre is one of the newest and best equipped facilities of its kind on the continent. This new dispatching centre has boosted police communications capabilities five-fold since it was put into operation in March of 1976. It is felt that direct digital access to the Ottawa information centre will usher in a new era in inter-provincial crime control. Further advantages of digital data transmission systems include the elimination of eavesdropping as well as cost reduction due to the decreased need for trained dispatchers at local headquarters.

Kaye, Roger and Toby Walker, "Adding Mobility to Computer Communications", Canadian Data (September 1981), p.38-41.

The authors state that computers and communications are increasingly affecting every phase of the transportation industry. In this paper, they present an overview of current developments on how such developments give computer communications new mobility. Among other topics, real-time dispatch is discussed.

Schmidt, James W. and Robert L. Knight, "The Status of Computer-Aided Scheduling in North America", Computer Scheduling of Public Transport, Edited by A. Wren, North-Holland Publishing Company (1981).

This paper begins with a brief historical review, and then surveys the experiences of North American transit operators which have tested or installed computer-aided scheduling systems. Following the survey, a brief description of other emerging and existing computer-aided systems related to scheduling. General conclusions are presented on the status of this field.

Skomal, Edward N., Automatic Vehicle Locating Systems, Van Nostrand Reinhold Company (1981).

Automatic vehicle locating (AVL) systems are described from the viewpoint of applications to large fleets of vehicles. This text opens with a basic discussion of the AVL system concept and how AVL systems may be employed. Several applications of this technology are described including those that have been field tested with differing technical approaches. The breadth of technical solutions now commercially available is emphasized by three categories of locating techniques: dead reckoning, proximity, and trilateration. The concerns of an AVL system user and operator are given prominence throughout this text.

Wren, Anthony (Editor), Computer Scheduling of Public Transport: Urban Passenger Vehicle and Crew Scheduling, North-Holland Publishing Company (1981).

This book is based on the Proceedings of a Workshop on this subject held at the University of Leeds in July 1980. In this volume, one paper is concerned with an underground railway; the others treat bus operations, although in most cases the methods would be applicable to other modes.

Wren, Anthony, "General Review of the Use of Computers in Scheduling Buses and Their Crews", Computer Scheduling of Public Transport, Edited by A. Wren, North-Holland Publishing Company (1981).

A number of subject areas are identified, and within some areas treatment is broken down by type of problem and by type of approach. This review deals more with methodology than with implementation. The author suggests that in the future schedules are likely to be compiled through an interactive process involving the schedules and the computer, each performing their most suitable function.

A3.4/ Ride-Sharing

Miller, Eric J., Paul D. Bunt and Frank J. Ahlin, "Computer Applications in Paratransit Reservations, Scheduling and Dispatching: A Case Study", RTAC Annual Meeting (1979).

This paper, based on research funded by the Ontario Ministry of Transportation and Communications, presents a review of the use of computers in paratransit control systems. It identifies a wide range of roles for the computer, from the provision of rudimentary "management information" data to the operator to the full automation of the entire reservation, scheduling and dispatching tasks. Also, an illustration of the use of computers, a specific case study, namely Toronto's Wheel-Trans service for the physically disabled, is described.

A3.5/ Freight Transportation and Distribution Management

"Computerized Truck Routing Saves 12 Man-Hours Per Day", Materials Management and Distribution (August 1978).

Gay Lea Foods Co-operative Limited is saving shipping staff at least 12 man-hours a day on servicing the company's 15 truck routes by including truck routing as a by-product of its computerized order entry/invoicing procedure. The computer system handles the following: order entry/invoicing; truck routing; sales analysis; general ledger summary posting report; inventory control; and accounts receivable.

"Datacomm Brings BC Firm Together", Computer Data, p.94.

A combined communications and computer technology has made it possible for a Vancouver firm's scattered and isolated installations to communicate efficiently. Riv Tow Straits Ltd. put together a dedicated network that is partly analogue and partly CCG's cross-Canada digital data route network.

"Dial-Up Computer Network Links 525 Grain Elevators to Speed Data, Cut Paperwork",

The huge Co-operative Saskatchewan Wheat Pool is building a data communication network based on minicomputers spread across a 350 square mile area connected to a central mini over dial-up lines. It has already 525 satellite processors.

Hancock, Geoffrey, "Computer Helps Truckers Slash Empty Backhauls", Canadian Transportation and Distribution Management, (May 1981), pp.55-56.

A computer-based system designed to eliminate empty backhauls is estimated to be capable of saving millions of litres of fuel for public and private fleet operations. A system known as Datafreight is described which was introduced by state-owned British Road Services (BRS), the largest trucking company in Britain. On a country-wide scale, the computer stores information about the location of cargo that needs to be moved and about vehicles that are available to carry it.

*Khan, Ata M., "Transportation and Telecommunications: A Study of Substitution, Stimulation and Their Implications", Report No.121, Systems Analysis and Research Data Base Branch, Canadian Transport Commission (June 1974).

This report offers an excellent summary of a wide variety of literature and recommends a framework for further research.

Lancashire, Ray, "Forwarders/Brokers Under Pressure To Upgrade Service", Canadian Transportation and Distribution Management, (May 1980), pp.25-27.

The author suggests that the increased use of computer technology by Canada Customs to reduce paperwork points to a real need for both forwarders and brokers to re-evaluate their place in the market.

McIntyre, Hugh, "Tracing Systems Upgraded for Faster, Easier Access", Canadian Transportation and Distribution Management (March 1981), p.32-34.

In response to today's low inventories and tight supplies, it is essential that the customer knows exactly where his freight is located. Both of Canada's major rail carriers have computerized car location systems that satisfy customers' requirements. This paper describes tracing systems that have been implemented.

Momberger, Fred, "Canadian Air Cargo Concepts", Airport Forum, Vol.6, No.6 (1976).

Air Canada's cargo information system (ACCESS) is described.

Oberman, Richard M., et al., "Initiatives for Conserving Transportation Energy Through Telecommunications", The Mitre Corporation (June 1980).

Randall, Keith, "Improving PD Efficiency Through Telecommunications", Canadian Transportation and Distribution Management (November 1981), pp.103.

Application of new technology now makes it possible to have distribution data available on a real-time basis instead of having to depend on information which is days or weeks olds.

"Shipping Line Controls Cargo Movements With Vancouver-Copenhagen Computer Communication Network", Communication Systems (April/May 1982), p.28-29.

With its head office in Canada, its computer system in Denmark, and ships all over the world, EAC-Knutsen has turned to a specialized data communications network to manage its operations and deal with agents. This agency organization includes 48 offices located both in ports of call and inland points. The physical link is EAC's private telex network tied to a central computer in Copenhagen, Denmark. This network in turn, is linked by satellite to another computer set-up at the line's Vancouver headquarters.

A3.6/ Telecommunications in Urban and Transportation Planning

Please see the following sources of information. These papers and reports have already been included in other sections of the Annotated Bibliography.

Khan, Ata M., "Travel vs. Telecommunication: Modelling Implications", High Speed Ground Transportation Journal, V.10, No.3 (Fall 1976).

Khan, Ata M., "Transportation and Telecommunications: A Study of Substitution, Stimulation and Their Implications", Report No.121, Systems Analysis & Research Data Base Branch, Canadian Transport Commission (June 1974).

Oberman, Richard M. et al., "Initiatives for Conserving Transportation Energy Through Telecommunications", The Mitre Corporation (June 1980).

AA/ TECHNIQUES FOR ASSESSING OPPORTUNITY AREAS (EVALUATION TECHNIQUES)

Bell Canada, "Delphi: The Bell Canada Experience", Montreal, Business Planning Group, H.Q. Planning (1972).

This report consists of five papers which describe the use of modified Delphi technique by Bell Canada in guiding their business decision-making. Bell's studies explored the future adoption of technology based services in four fields: Education, Medicine, Business, and the Home. These studies also investigated many non-technological factors such as future value trends, evolution in school design, the changing role of the teacher, trends in the medical profession and environment, changes in business procedures and business physical environments, as well as consumer attitudes towards "wired city" services.

Kazanowski, A.D., "A Standardized Approach to Cost- Effectiveness", Cost Effectiveness: The Economic Evaluation of Engineered Systems, Edited by J. Morley English, John Wiley & Sons, Inc. (1968).

The concept, theory and methodology of cost-effectiveness is described. Special treatment of the system evaluation criteria is provided.

Khan, A.M., "Transport Policy Decision Analysis: An Expected Utility Approach", High Speed Ground Transportation Journal, Vol.5, No.2 (Summer 1971), pp.199- 214.

This paper presents an expected utility approach for the formal treatment of the uncertain nature of impacts of transport policy alternatives, and the decision-maker's preference structure for these impacts. This approach, based on the concepts of expected utility and subjective probability, lends itself to the exploration of the implications of uncertainty on the final decisions.

Khan, A.M., "Transport Policy Decision Analysis: Recent Developments in the Techniques of Investment Planning", High Speed Ground Transportation Journal, Vol.6, No.1, (Winter-Spring 1972).

Techniques of transport investment planning are surveyed. Methodology is evaluated with respect to the requirements to be satisfied. Problems associated with poor specification of system evaluation criteria, differential impacts of system changes, various uncertainties and the wider nature of the impacts on urban and regional development are highlighted.

Lifson, M.W., "Value Theory", Cost-Effectiveness: The Economic Evaluation of Engineered Systems, Edited by J. Morley English, John Wiley & Sons, Inc. (1968).

The meaning of utility in the context of system evaluations is discussed. The example of the U.S. SST program is used as a case study.

Manheim, M.L., "Reaching Decisions About Technological Projects With Social Consequences: A Normative Model", Systems Planning and Design:

Case Studies in Modelling, Optimization and Evaluation, Edited by de Neufville R. and D. H. Mark, Prentice-Hall (1974).

Methodology and issues in evaluating technological projects with social consequences are discussed.

Quade, E.S., "Cost Effectiveness: Some Current Trends in Methodology", Cost Effectiveness: The Economic Evaluation of Engineered Systems, Edited by J. Morley English, John Wiley & Sons, Inc.(1968).

A number of evaluation approaches are discussed including direct use of expertise and the Delphi Method.

Shimpler, C. C. and Grecco, W. L., "System Evaluation: An Approach Based on Community Structure and Values", Highway Research Record #238 (1968).

This paper presents a procedure for the evaluation of alternative transportation system design concepts based on a comprehensive, weighted hierarchy of community development criteria. Existing techniques for alternative plan evaluation including criteria weighting are summarized.

Stopher, P.R. and A.H. Meyburg, Transportation Systems Evaluation, Lexington Books, D.C. Heath and Company (1967).

Methods of evaluation are surveyed in this book and also the identification, measurement and interpretation of impact are discussed. Among other interesting features of this book, a method of weighting effectiveness is illustrated.

POOR

QUALITY

ORIGINAL